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May 23, 1903



Columbia University Bulletins of Information

DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BOTANY,
PHYSIOLOGY, PHYSIOLOGICAL CHEMISTRY,
ZOÖLOGY

ANNOUNCEMENT

1903-1905

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Columbia University

Bulletins of Information

(Issued 25 times during the Academic Year, monthly in November and December, and weekly between February and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under Act of July 16, 1894.)

These include :

1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, issued in December, price 25 cents.
3. The Announcements of the several Colleges and Schools and of certain Divisions, issued in the spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University.

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Professor BASHFORD DEAN, *Secretary*

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GEORGE S. HUNTINGTON, M.D.....	Professor of Anatomy
HENRY FAIRFELD OSBORN, Sc.D., LL.D..	<i>Da Costa</i> Professor of Zoölogy
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T. MITCHELL PRUDDEN, M.D., LL.D.....	Professor of Pathology and
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	<i>Bacteriology and Hygiène, and Clinical Pathology</i>
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FRANCIS ERNEST LLOYD, A.M.....	Adjunct Professor of Biological

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CARLETON PHILIPS FLINT, M.D.... Assistant Demonstrator of Anatomy

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JAMES HOWARD MCGREGOR, Ph.D.....	<i>Instructor in Zoölogy</i>
BERN B. GALLAUDET, M.D.....	<i>Demonstrator of Anatomy and</i> <i>Instructor in Surgery</i>
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ADRIAN VAN SINDEREN LAMBERT, M.D.....	<i>Assistant Demonstrator of</i> <i>Anatomy</i>
CARLETON PHILIPS FLINT, M.D....	<i>Assistant Demonstrator of Anatomy</i>

EUGENE HILLHOUSE POOL, M.D.	Assistant Demonstrator of Anatomy
HAVEN EMERSON, M.D.	Assistant Demonstrator of Physiology
WILLIAM DARRACH, M.D.	Assistant Demonstrator of Anatomy
GUY COCHRAN, M.D.	Assistant Demonstrator of Physiology
LEANDER HOWARD SHEARER, M.D.	Assistant Demonstrator of Physiology
CARLTON CLARENCE CURTIS, Ph.D.	Tutor in Botany
OLIVER S. STRONG, Ph.D.	Tutor in Comparative Neurology and Assistant in Normal Histology
ALFRED NEWTON RICHARDS, Ph.D.	Tutor in Physiological Chemistry
WILLIAM E. KELLICOTT, A.B.	Tutor in Zoology
TRACY ELLIOT HAZEN, Ph.D.	Tutor in Botany
ADA WATTERSON, A.B.	Tutor in Biology in Teachers College
ROLFE FLOYD, M.D.	Lecturer in Anatomy
AUGUSTUS B. WADSWORTH, M.D.	Assistant in Bacteriology and Hygiene
PHILIP BOUVIER HAWK, M.S.	Assistant in Physiological Chemistry
CHARLES NORRIS, M.D.	Assistant in Bacteriology and Hygiene
HOMER D. HOUSE, A.B.	Assistant in Botany
PAULINE HAMILTON DEDERER, A.B.	Assistant in Zoology

MEMBERS OF THE STAFF OF THE BOTANICAL GARDEN GIVING INSTRUCTION IN THE DIVISION

NATHANIEL LORD BRITTON, Ph.D.	Director and Emeritus Professor of Botany
DANIEL TREMBLY MACDOUGAL, Ph.D.	Director of the Laboratories
JOHN KUNKEL SMALL, Ph.D.	Curator of the Museums
PER AXEL RYDBERG, Ph.D.	Assistant Curator
ARTHUR HOLLICK, Ph.D.	Assistant Curator
MARSHALL AVERY HOWE, Ph.D.	Assistant Curator
FRANKLIN SUMNER EARLE, A.M.	Assistant Curator
GEORGE VALENTINE NASH	Curator of the Plantations
HENRY HURD RUSBY, M.D.	Curator of Economic Collections

Partial Courses are also Given by.

ELIZABETH GERTRUDE BRITTON
EDWARD SANFORD BURGESS, Ph.D.

DIVISION OF BIOLOGY

The Division of Biology includes the departments of Anatomy, Bacteriology, Botany, Physiology, Physiological Chemistry, and Zoölogy in all schools of the University. The present announcement is therefore designed to give under separate headings a list of all biological courses whether in the College, the School of Pure Science, the College of Physicians and Surgeons, Barnard College, or Teachers College. Under each subject will be found courses ranging from introductory to the most advanced.

General Facilities for Biological Work

The facilities for biological work in Columbia include the special laboratories of the various schools, the general library of the University, and special departmental libraries. An arrangement with the American Museum of Natural History enables advanced courses to be given at the Museum and makes the collections accessible to students. A similar arrangement permits University courses and experimental work to be carried on at the New York Botanical Garden. By special permission students can also obtain access to the material of the New York Aquarium and of the New York Zoölogical Society. Advanced students are eligible for work places maintained by the University at zoölogical stations: at Naples there is usually available one table, at Woods Hole two, and at Cold Spring Harbor one, the last in connection with the John D. Jones Scholarship.

Coördination of Courses for a Degree

In the present announcement each course of study is given a value in terms of a degree in the Colleges or in the University. In the Colleges a course would thus be reckoned as contributing a definite number of "points" toward a degree or diploma. In the University, however, the course is given a value in terms of major or minor "residence" requirements for the degree of Master of Arts, or Doctor of Philosophy. For these degrees a candidate shall select one principal or major subject and two subordinate or minor subjects, the major to be equivalent to the sum of the minors. In further detail: a major for the degree of Doctor of Philosophy is theoretically equivalent to two minors for that degree, or four majors or eight minors for the degree of Master of Arts. And this ratio is approximately maintained in the estimate of the value of courses.

In the present announcement the time requirement for individual courses is stated in numbers of hours per week, and this arrangement is constant throughout the entire year, unless otherwise specified.

GENERAL INFORMATION

The Deans of the Faculties concerned should be consulted by students wishing to pursue courses of study, to the end that suitable choice of courses may be made.

The attention of graduate students is called to the fact that the Summer Session of the University offers a number of courses which are accepted in partial fulfilment of the requirements for the higher degrees. The announcement of the Summer Session will be sent upon request.

For conditions of admission to Columbia College, Teachers College, or Barnard College, see the circular upon entrance examinations, which may be had upon application to the Secretary of the University.

Candidates for the degrees of Master of Arts and Doctor of Philosophy must hold a baccalaureate degree in arts, letters, philosophy, or science, or an engineering degree, or an equivalent of one of these from a foreign institution of learning. Every candidate for a higher degree must present to the Dean of each school in which he intends to study, satisfactory evidence that he is qualified for the studies he desires to undertake.

No course need be given unless there be entered for it at least three candidates for a degree.

Many of the courses are open to students not candidates for a degree on payment of an auditor's fee. But no auditor will be admitted who has not secured the consent of the instructor.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those granted to men.

The Academic year begins thirty-seven weeks prior to Commencement, which occurs on the Wednesday nearest the 11th of June. For 1903-04 these dates will be, respectively, September 23, 1903, and June 8, 1904. The Academic year is divided into two half-years of fifteen weeks of instruction each. In 1903-04 the second half-year begins on February 1, 1904. The exercises of the University are suspended on Election Day, Thanksgiving Day and the following two days, for two weeks at Christmas, from the Thursday before Good Friday through the following Monday, and on Memorial Day. The complete Academic calendar will be found in the University catalogue, and so far as it refers to the students studying under any Faculty, in the Announcement of that Faculty.

The details regarding registration, the payment of fees, and the like, will be found in the Announcement of the Department of the University which the student proposes to enter. The fee for candidates for the degrees of A.B., B.S. (in Education), A.M., and Ph.D.

is \$150, payable in half-yearly instalments, that for candidates for M.D. and the degrees in Applied Science, \$200. A matriculation fee of \$5 is required of all students, and the fees for examination for the several degrees are as follows: A.B. and B.S. in Education, \$15; A.M. and the technical degrees in Applied Science and Medicine, \$25; Ph.D., \$35.

In the Announcement of the Faculties of Political Science, Philosophy, and Pure Science will be found a statement of the Laboratory Fees required of students not candidates for a degree.

The following special regulations of the Faculty of Pure Science should have the attention of students under that Faculty.

The student is expected to gain a sound general knowledge of the two minor subjects of his choice. In the major subject a much more thorough and special knowledge is required, particular importance being attached to training in research. In the School of Pure Science, however, two subjects can be chosen in the same department only by special vote of the Faculty. By this means undue specialization can be controlled.

The approval of the subject of the dissertation required for the degree of Master of Arts, or of Doctor of Philosophy, rests with the instructor in charge of the candidate's major subject. It is desirable that the studies upon which a dissertation is based, should be related, and when practicable, that they should be treated respectively as preliminary and completed investigations. Great importance is attached to the character of the final dissertation. While it must depend for acceptance chiefly on the subject-matter, it should show good literary workmanship, especially by directness and clearness of statement. It should demonstrate the author's capacity to do original scientific work and to render an intelligible account thereof. It should evince a familiarity with the literature of the subject and with the latest methods of research. The treatment should be as concise as the nature of the work permits. Every dissertation should be preceded by a clear introductory statement setting forth the nature and the scope of the research, and be followed by a résumé of the results and the conclusions obtained. It should also be accompanied by a table of contents and by a list of the authorities consulted in its preparation.

TABLE SUGGESTING COMBINATIONS OF SUBJECTS IN THE DIVISION

MAJOR SUBJECTS.	MINOR SUBJECTS.	
Anatomy	Physiology	Zoölogy
	Zoölogy	Botany
	Physiology	Physiological Chemistry
Bacteriology	Zoölogy	Botany
	Zoölogy	Physiology
	Botany	Physiological Chemistry
Botany	Zoölogy	Physiological Chemistry
	Zoölogy	Bacteriology
	Zoölogy	Physiology
Physiology	Anatomy	Zoölogy
	Zoölogy	Botany
	Physiological Chemistry	Bacteriology
Physiological Chemistry	Physiology	Botany
	Zoölogy	Physiology
	Botany	Zoölogy
Zoölogy	Botany	Physiology
	Physiology	Physiological Chemistry
	Bacteriology	Physiological Chemistry

The Degrees of Master of Arts and Doctor of Philosophy

Candidates for the degrees of Master of Arts and Doctor of Philosophy must pursue their studies in residence for a minimum period of one and two years, respectively. The complete regulations will be found in the *Announcement of the Faculties of Political Science, Philosophy, and Pure Science*. This Announcement contains also a detailed statement as to the election of major and minor subjects, and an estimate of the amount of time necessary for their completion.

In practice three years of study are usually necessary to obtain the degree of Doctor of Philosophy.

Fellowships and Scholarships

Columbia University expends nearly \$75,000 annually in assisting deserving students. There are eighteen University Fellowships, of an annual value of \$650 each, and in addition three specially endowed fellowships open to advanced students in biological research; forty-two University Scholarships, including four open to women, of an annual value of \$150 each, available for students under the Faculty of Pure Science; and numerous scholarships for undergraduates in Columbia College, Barnard College, and Teachers College. There is a special scholar-

ship in biology amounting to \$200 awarded annually by the Wawepex Society. This includes the use of a biological table at Cold Spring Harbor, Long Island.

The regulations governing the award of fellowships and scholarships will be found in the appropriate University bulletins to which reference has already been made, and the blank forms of application may be obtained from the Secretary of the University.

The University maintains committees both to assist students in earning money during their term of residence at the University, and also to recommend graduates for teaching and other educational positions. These committees are known respectively as the Committee on Employment for Students and the Appointment Committee.

Funds and Prizes

Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal competition. These prizes are open therefore to students of the Division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

Equipment

In Anatomy

In the Department of Anatomy the laboratory facilities are very complete. The large general dissecting-room accommodates from 390 to 546 students at a time, working in groups of five or seven, respectively, at one table.

The laboratory for advanced morphological research occupies the third story of the Anatomical Building. Every facility for advanced and research work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

In Bacteriology

The work in Bacteriology is conducted in a special section of the northern wing of the College of Physicians and Surgeons in the Department of Pathology. The laboratories for the morphological and biological study of micro-organisms are suitably equipped, and the systematic study is greatly facilitated by the maintenance of the large collection of the known forms of bacteria under cultivation. The facilities for work in photomicrography, which are maintained in connection with the Department of Pathology, are accessible to workers in bacteriology.

In Botany

The laboratories and lecture room of the Department of Botany on the third floor of Schermerhorn Hall are devoted to undergraduate work. These are supplied with modern instruments for experiment and demonstration. A new conservatory and culture room maintained at a nearly constant temperature furnishes facilities for experimentation in plant physiology and a supply of fresh material for laboratory use. The courses of instruction are illustrated with a supply of charts, models, and lantern slides. Such needed works of reference as are useful to undergraduates are accessible in the general laboratory, where they are more directly available in connection with practical laboratory work. Special attention is given to field work.

Similar opportunities for the work of women undergraduates are offered in the laboratories at Barnard College.

The Museum of the New York Botanical Garden is located near the Bronx Park Station of the Harlem division of the N.Y. C. & H.R.R.R., and its entire upper floor is devoted to research. The library is housed under the dome and in a stack-room extension to the rear. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. The present floor space for the laboratories, library, and herbarium amounts to 19,000 square feet, in addition to which some space is afforded for special purposes on the basement floor. The laboratories include a suite of fourteen rooms, giving separate facilities for work in the main divisions of the subject. The equipment includes the apparatus necessary for research. Among special features are the dark rooms, photographic operating and balance room, constant-temperature chambers, and skylighted apartment for living plants, which is furnished with a suitable aquarium. Ample space for experimental work is provided in the propagating houses and in the open-air plantations.

The graduate courses in Botany are conducted at the Museum, in accordance with an agreement entered into between the University and the managers of the Garden, by which the University has deposited with the Garden its botanical collections and, in large part, its library except such works as are needed in the undergraduate work. The Garden on its part supplies all needed facilities for research and the use of its library, herbarium, museums, and conservatories. By this concentration of botanical interests the department is materially enriched in equipment and collections, and it can thus offer exceptionally favorable facilities for botanical research.

One of the distinctive features of the graduate work is a weekly botanical convention held each Wednesday at 4.30 P.M., where members of the staff and students present either the results of their own work or review the progress of botanical research and publication elsewhere.

The Columbia Herbarium and the equally extensive collections of

the New York Botanical Garden are housed in the large room of the east wing of the Botanical Museum. The two collections aggregate nearly a million specimens and are exceptionally full in every group of plants, from slime moulds to composites. Additions are being made each year of about 100,000 specimens.

The portion of the University Library classified under Botany is deposited in the library stack-room of the Museum building, where it can be consulted in connection with the extensive supplementary collection now owned by the New York Botanical Garden. The University Library now contains about 5000 bound volumes pertaining to Botany, together with about 4000 pamphlets and extracts; the Garden library supplements this by nearly 6000 volumes. These volumes, however, do not represent the entire reference facilities for the student, for all general works, scientific journals, and the publications of general scientific societies are shelved in the main library of the University. All the regularly published journals devoted to Botany proper (about seventy-five) are received and the sets are usually complete.

In Physiology

The Department of Physiology possesses:

I. At the College of Physicians and Surgeons:

- (1) A laboratory for research and the preparing of demonstrations.
- (2) A small laboratory for histological research with special reference to physiological problems.
- (3) Two rooms for optical or psychological work or for photography.
- (4) Two private laboratories for the Professors of the Department.
- (5) Two laboratories for practical instruction.
- (6) A room for recitations, lectures, and demonstrations to limited classes.
- (7) Easy access to a large lecture-room, specially fitted for experimental teaching.
- (8) The Swift Physiological Cabinet for the accommodation of a specially endowed and very full collection of apparatus of precision, mainly for research.

II. In Schermerhorn Hall: The use of a laboratory equipped for the instruction of undergraduates.

The physiological journals in English, German, and French are accessible to the students of the Department; also the most important books, both modern and ancient.

A skilled mechanic is employed to devote his entire working time to the care and improvement of the plant, including the making, altering, and repairing of special apparatus. He also assists in the scientific manipulations.

An investigator's room at the Marine Biological Laboratory at Woods Hole, Mass., has been provided by the University for the use of the Department of Physiology. This renders possible, during the summer, researches upon the physiology of the marine fauna.

In Physiological Chemistry

The Department of Physiological Chemistry is located in the College of Physicians and Surgeons and possesses five well-equipped rooms for experimental work. One large room is arranged for the accommodation of seventy-two workers. Four smaller rooms are specially fitted up for original investigation. The Department is well equipped with all needful apparatus for routine and research work in physiological chemistry.

The private library of Professor Gies is housed in the laboratory and is available to all students of the University.

In Zoölogy

The zoölogical laboratories on the upper floor of Schermerhorn comprise a large general undergraduate laboratory, two graduate laboratories, a laboratory for neurology, and eight rooms for private research, besides special rooms for supplies, aquaria, and preparation. There are also a commodious lecture-room, a library, and a seminar room. The laboratories are well equipped with optical instruments, microtomes, and other apparatus for advanced work. The teaching collections include a large series of the Mediterranean and American marine types, the injected vertebrate series of Fric and Müller, an extensive set of standard and specially prepared charts and wax models, and a variety of living animals and plants contained in fresh-water and marine aquaria.

The departmental library, a part of the University library kept in the laboratory, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes the journals and a rapidly increasing collection of special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. Forty-three of the current biological journals are subscribed for.

Journal Club

One of the special features of the department is the journal club, open to instructors and all advanced students, and meeting every week in the departmental library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

Field Work

The Marine Biological Laboratories at Wood's Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, two investigators' rooms are subscribed for by the University for the use of the departments of Zoölogy and Physiology; in the latter a table is available through the John D. Jones Scholarship. Cir-

culars of the summer courses are obtainable in the department. Through William E. Dodge, Esq., the University also subscribes to one-half of the American University Table at the Naples Zoölogical Station. Applications should be made to Professor Wilson.

In addition to the above facilities field-expeditions are from time to time sent out by the department. In 1896 a laboratory was established upon Puget Sound, at Port Townsend, Washington. The investigation of the Pacific fauna, thus begun, was continued during 1897 and 1899 at different points along the coast from Monterey, California, to Sitka, Alaska, and the faunal and morphological reports of this work are now being published. Through the liberality of Charles H. Senff, Esq., two expeditions to the Nile were made during the summers of 1898 and 1899 by N. R. Harrington (Fellow), F. B. Sumner (Fellow), and Dr. Reid Hunt (a member of the staff in physiology). For several summers past parties have worked at Beaufort, N. C., at Woods Hole, Mass., and at other points on the Atlantic Coast. In 1901-02 was begun a biological examination of the marine fauna of the south shore of Long Island.

Publications

The University Press issues the *Columbia University Biological Series*, a number of educational volumes originally founded upon public lectures, of which seven have already appeared and two others are in preparation. Another feature in advanced instruction is the connection with the biological section of the New York Academy of Sciences, which affords opportunities for reading, discussing, and printing scientific papers.

Two series of publications are issued from the Department of Botany: a quarto series known as the *Memoirs of the Department of Botany*, of which two volumes have been published; and the *Contributions from the Department of Botany*, in octavo, which have nearly completed the eighth volume.

DEPARTMENTS OF INSTRUCTION

Anatomy

Courses that may be taken for the Degrees of Master of Arts and Doctor of Philosophy

Course 11 may be offered as a major or minor for the degree of A.M. or Ph.D. according to special arrangement with the head of the department. It is optional for qualified candidates for the degree of M.D.

Courses 12-23 may be offered each as a minor for the degree of A.M. They are optional for candidates for the degree of M.D., and are open to post-graduate students in medicine. Minimum number of hours required six per week from October 15th to April 1st.

Course 24 cannot be counted for a degree. It is open to teachers and qualified graduate students.

None of the courses of the Department of Anatomy is open to women.

Research

11—The laboratory of animal morphology is open for research, under the direction of the professor, to advanced workers.

12—**Comparative Morphology of the Carpus**—A comparative study of the carpus in vertebrates above fishes, with especial reference to the homologies of the components, their evolution and significance, and their mutual relations in amphibia, reptiles, birds, and mammals.

13—**Comparative Morphology of the Respiratory Apparatus in Mammals, Sauropsida, and Bactrachia**—Evolution of the composite mammalian lung from the air-sac—Morphology of mammalian bronchial tree—Construction of terminal branches and end spaces—Skeletal and other modifications of the respiratory apparatus in birds.

14—**Comparative Morphology of the Central Nervous System**—Demonstration and laboratory course—Detailed work in brain of cod, frog, turtle, bird, and mammal.

15—**Comparative Morphology.**

(a) Appendicular muscles.

(b) Ventro-appendicular muscles.

(c) Muscles of the foot.

16—**Human and Comparative Morphology of the Auditory Apparatus.**

17—**Comparative Morphology of the Upper Respiratory Passages, Nares, Larynx, Epiglottis, Syrinx.**

18—**Comparative Morphology of the Uro-Genital System.**

19—**Cranial Topography**—This course is designed for advanced students possessing a knowledge of the gross morphology of the human brain.

Pre-requisite: Course 7, or its equivalent.

20—**Comparative Morphology of the Heart and Vascular System**—Development and modification of the venous system in vertebrates.

21—**Comparative Morphology of the Alimentary Tract and Digestive Glands**—Anatomy of the peritoneum.

22—**Comparative Morphology of the Cæcum and Ileo-Colic Junction in Vertebrates**—Detailed study of the modification of the structures and their vascular and serous relations.

23—**Topography of the Pelvic Viscera, Muscles, and Fasciæ.**

24—**Anatomical Technology and Museum Methods.**

In all courses offered in morphology the work is designed to be laboratory exercises of at least two continuous hours' duration at any one exercise, supplemented in certain courses by demonstration and

study of material contained in the Museum of Human and Comparative Anatomy and in the study collections of the department.

The time required for the above courses if offered as minors for the degree of A.M. is half a day per week from October to April.

The courses are given on Tuesday afternoons at the Anatomical Laboratory, College of Physicians and Surgeons, by Professor HUNTINGTON and Dr. DARRACH.

By special arrangement other hours are assigned to work in the cases of advanced students and investigators.

The demands on laboratory space and teaching force rendered it necessary to limit the number of candidates admitted to these courses.

Other Courses Offered

Courses 2, 3, and 5 are required in the first year of candidates for the degree of M.D. The four courses together may be elected by Seniors in Columbia College.

Courses 1, 6, 7, 8, and 9 are required in the second year of candidates for the degree of M.D.

1—**Vertebrate Morphology**—Anatomy of the body cavities—Visceral and topographical course—Thorax and abdomen. Lectures combined with demonstrations. Three hours. Professor HUNTINGTON.

2—**Demonstrations to sections of the class**—Cranial osteology, syndesmology, myology, peripheral nervous system, and angiology of the head and neck. One hour. Dr. LAMBERT

3—**Demonstrations to sections of the class**—Osteology, syndesmology, myology, peripheral nervous system, and angiology of the extremities. Two hours. Drs. CARMALT and VOSBURGH

These courses are so arranged as to maintain, with reference to the subjects treated, a direct connection with the laboratory course in dissection, No. 5.

5—**Laboratory Course—Dissection of the Human Body.** Eighteen to twenty hours a week, at various hours, for from three to five periods of four weeks each. Professor HUNTINGTON, Dr. GALLAUDET, and the ASSISTANT DEMONSTRATORS OF ANATOMY

6—**Laboratory Course—Dissection of the Human Body.** Ten to twelve hours a week for from six to eleven weeks. Professor HUNTINGTON, Dr. GALLAUDET, and the ASSISTANT DEMONSTRATORS OF ANATOMY

7—**Demonstrations to sections of the class**—Anatomy of the mouth, pharynx, and larynx—The auditory apparatus—The central nervous system. Three hours. Dr. GALLAUDET

8—**Demonstrations to sections of the class**—Visceral anatomy. This course preserves an organic connection with Course 1, and presents for direct examination and demonstration the preparations serving to illustrate that course. Two hours. Dr. DARRACH

9—Demonstrations to sections of the class—Anatomy of the cranial nerves. One hour for one half-year. Dr. FLINT

10—Course in Mammalian Morphology—Introductory to the course in Physiology. Two hours for first half of the year.

For courses in Comparative Anatomy, vertebrate and invertebrate, See also Department of Zoölogy, Courses Zoölogy 2, 3, and 5, especially 3 (d): Mammalian Dissection (Dr. MCGREGOR).

Bacteriology

Preliminary Statement

Candidates for A.M. and Ph.D. taking these courses are required to have a working knowledge of the microscope and a general acquaintance with elementary biology and practical elementary chemistry. No preliminary work in bacteriology.

There are no courses in this department providing the necessary preliminary training; but this may be secured in Course No. 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoölogy in the Department of Zoölogy.

None of the courses in this department is open to women, nor to Seniors in Columbia College.

Courses that may be taken for the Degrees of Master of Arts and Doctor of Philosophy

2—Advanced Bacteriology—There is an opportunity each year for a few graduates in medicine, or other qualified workers, to receive a special course in practical bacteriology. The laboratory is abundantly supplied with apparatus for the culture and study of micro-organisms, and has under cultivation a large collection of identified species. In this course the applications of bacteriology to sanitation and to practical medicine are held in view.

Methods of preparation, staining, microscopic study, and measurement of bacteria. Preparation of culture media; study and record of observation of selected typical species; systematic analyses for determination of unknown species; methods of isolation of species; qualitative and quantitative biological examinations of water, soil, and air; methods of determining pathogenic properties, disinfection, modes of testing value of germicides, etc.

Text-books: Muir and Ritchie's *Manual of Bacteriology*, Flüggé's *Mikroorganismen*, Macé's *Bacteriologie*.

This course requires attendance at the laboratory during the entire afternoon in January, February, and March. Dr. HISS assisted by Drs. WADSWORTH and NORRIS

Minor for one year for the degree of A.M. or Ph.D.

3—Advanced Bacteriology with Research—As under Course 2, with additional study of known species of bacteria; special study of the

chemical products formed in the growth of bacteria; practical work in photomicrography, and the pursuit of some selected theme for original investigation. Professor PRUDDEN and Drs. HISS and LEAMING

Text-book: Kolle and Wassermann's *Handbuch der pathogenen Mikroorganismen*.

Attendance and hours as in Course 2, with additional time for research.

Major for one year for the degree of A.M. or Ph.B.

Other Courses Offered by the Department

1—Elementary Bacteriology, especially adapted to the requirements of students of medicine, six hours a week for one quarter of the academic year; given in the Department of Pathology under the Medical Faculty. Drs. HISS, WADSWORTH, and NORRIS

Photography and Photomicrography

Practical instruction is given to a limited number of men in the photographic laboratories of the College, in the technique of photography and photomicrography. The time necessary for the acquirement of this technique varies with the facility of the student and the hours devoted to the theme, and is subject to special arrangement. Given in the Department of Pathology under the Medical Faculty.

The facilities of these laboratories may be drawn upon for purposes of record and illustration by instructors and investigators in various departments of the University. Dr. LEAMING.

Research

Research in bacteriology may be pursued in the laboratories of this department by a limited number of graduate students or practitioners of medicine or other advanced workers, under the direction of the professor. To such men the large collection of bacterial cultures belonging to this department are accessible. Professor PRUDDEN and Dr. HISS

Another Course Offered in the University

Teachers College. An elementary course in bacteriology is given under the Department of Biology of Teachers College. (Second half-year only: M. and W., 9.30–11.30.) Professor BIGELOW in collaboration with Professor LLOYD. (See Teachers College Catalogue: Biology 12.)

Botany

Graduate work in botany presupposes the possession of a knowledge of the principles of general biology, and the subject-matter of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology

and a good knowledge of microscopic technique. Major work in the subject presupposes the ability to commence a definite line of research under the direction of an instructor. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued as a three-hour subject for three years. Courses 1-4 cited below, or their equivalent, together with Course 5 or Course 7 according as the trend is toward morphology or physiology, form the necessary preparation for commencing a major in botany. Course 1 with any two additional courses or an equivalent will be required as the necessary preparation for commencing a minor in botany.

All major courses and most minor courses are conducted at the Museum building of the New York Botanical Garden, under the direction of members of the botanical staff of the University and of the Garden staff:

All graduate courses are open to women.

Courses 9, 10, 11, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 31, may be taken as major work for A.M.

Course 3 combined with Course 7, or a proportionate amount of work in Courses 9, 10, 16, 18, 19, 20, 22, 23, 24, 25, may be taken as minor work for A.M.

Courses 12, 13, 14, 15, 27, 28, 29, 30, may be taken for major work for Ph.D.

Any two of the Courses 9, 10, 11, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 31, or a proportionate amount of work in Courses 12, 13, 14, 27, 28, 30, may be taken as a minor for Ph.D. In some cases the accomplishment of an approved piece of research may be offered as a minor for Ph.D.

Graduate students preparing for the profession of teaching are expected to take Education 12 at some time during their course of study.

Course 1 or its equivalent is pre-requisite for all succeeding courses, except Course 8.

Course 2 for Courses 5, 9, 14, 21, 26, 30, 31.

Course 3 for Courses 11, 12, 16, 17, 27, 28, 30.

Course 4 for Courses 9 (if offered as a major for A.M.), 10, 14 (if subject chosen is a group of cryptogams), 18, 19, 20, 22, 23, 24, 25, 30.

Course 5 for Courses 9 (if offered as a major for A.M.), 11, 13, 18, 19, 20, 21, 30.

Course 7 for Courses 12, 16, 17, 27, 28, 30.

Course 8 is required of first-year students in civil engineering.

Courses Leading to the Degrees of Master of Arts and Doctor of Philosophy

3, 7—(See below.) Although primarily intended for undergraduates, if preceded by Courses 1, 2, and 4, and supplemented by additional reading and experiment, may be offered as a minor for A.M.

9—Taxonomy of Spermatophyta—Study of the principal families

and general field and laboratory work. Not less than ten hours a week for one year. Professor BRITTON, Dr. SMALL, and Dr. RYDBERG

10—Morphology of Fungi—Study of the structure, polymorphism and development of the fungi, including culture methods. Field and laboratory work. Not less than ten hours a week for one year. Mr. EARLE

11—Experimental Morphology—A study of the variation of form and structure, and the determination of the causes. Not less than ten hours a week for one year. Drs. MACDOUGAL and CURTIS and Professor LLOYD

12—General Physiology—Problems in absorption, excretion, nutrition, and transformation of energy, growth, the general irritable organization of the plant, and the mechanism of its movements. Laboratory. Not less than ten hours a week for three years. Drs. CURTIS and MACDOUGAL, and Professor RICHARDS

13—Embryology of Spermatophyta—Comparative embryology of special groups. Special embryological problems. Technique. Not less than ten hours a week for three years: or, with special work during two summers, two years. Professor LLOYD

14—Special Taxonomy—Critical study of a family or genus of plants of not less than fifty species. The group may be chosen from the entire range of the vegetable world. Field, herbarium, laboratory, and garden work. Not less than ten hours a week for two years with field work during two seasons. Directed, according to the group chosen, by Professor UNDERWOOD, Professor BRITTON, Dr. HOWE, Dr. SMALL, Dr. RYDBERG, Mr. NASH, Professor BURGESS, and Mrs. BRITTON

15—Regional Botany—Collection, determination, and comparative study of the plants of some restricted area. Field, herbarium, and laboratory work. Not less than ten hours a week for two years, including field work during two seasons. Professors UNDERWOOD and BRITTON

Pre-requisite: three years' work in botany.

16—Physiology of the Cell—Problems in the chemical and the physical properties, movements, and irritability of unicellular and other generalized organisms. Laboratory. Not less than ten hours a week for one year. Dr. MACDOUGAL

17—Plant Geography—Occurrence, characters, and arrangement of groups and formations. Relations of plant societies to one another, and to topographic, climatic, and other conditions. Factors governing distribution. Not less than ten hours a week for one year. Professor BRITTON, Dr. MACDOUGAL, Professor LLOYD and Dr. CURTIS

18—Morphology of Algæ—Study of the structure and development of algæ. Field and laboratory work. Not less than ten hours a week for one year. Dr. HOWE, Professor RICHARDS and Dr. HAZEN

19—Morphology of Bryophyta—Study of the structure and development of the musci and hepaticæ. Field and laboratory work. Not less than ten hours a week for one year. Professor UNDERWOOD, Dr. HOWE, and Mrs. BRITTON

20—Morphology of Pteridophyta—Study of the structure and development of the ferns and fern-allies. Field and laboratory work. Not less than ten hours a week for one year. Professor UNDERWOOD

21—Morphology of Spermatophyta—Study of the structure and development of the seed plants. Field and laboratory work. Not less than ten hours a week for one year. Professor LLOYD, Drs. RYDBERG and CURTIS

22—Taxonomy of Algæ—Study of the diagnostic characters and relationships of the principal families and genera. Field and laboratory work. Not less than ten hours a week for one year. Drs. Howe and HAZEN

23—Taxonomy of Fungi—Study of the diagnostic characters and relationships of the principal families and genera. Field and laboratory work. Not less than ten hours a week for one year. Professors UNDERWOOD and EARLE

24—Taxonomy of Bryophyta—Study of the diagnostic characters and relationships of the principal families and genera. Field and laboratory work. Not less than ten hours a week for one year. Professor UNDERWOOD, Dr. HOWE, and Mrs. BRITTON

25—Taxonomy of Pteridophyta—Study of the diagnostic characters and relationships of the principal families and genera. Field and laboratory work. Not less than ten hours a week for one year. Professor UNDERWOOD

26—Taxonomy of Gramineæ—Study of the diagnostic characters and relationships of the principal genera. Field and laboratory work. Not less than ten hours a week for one year. Mr. NASH

27—Physiology of Nutrition—Treated from a chemical standpoint. Not less than ten hours a week for three years. Professor RICHARDS

28—Ecological Physiology—Problems in adaptive reactions in form, structure, and movements to external energy and environmental factors. Field and laboratory work. Not less than ten hours a week for three years. Drs. MACDOUGAL and CURTIS

29—Physiological Anatomy—Problems in the relationships of tissues and functions. Laboratory work. Not less than ten hours a week for three years. Dr. CURTIS

30—General Plant Pathology—Study of diseases caused by parasitic fungi and bacteria with special attention to the morphology of the pathological organism. Also problems in immunity, and effects of unfavorable environment. Field and laboratory work for two years, including two summers in the field. Mr. EARLE

31—Developmental Taxonomy—Fossil ancestors of some family of plants. Comparative study of form and structure. Laboratory and museum. Not less than ten hours a week for one year. Dr. HOLLICK.

(For course in **Palæobotany**, see **Geology**. For course in **Physiological Chemistry of Plants**, see **Physiological Chemistry**, Course 4, on p. 26.)

Other Courses Offered by the Department

1—Elementary Botany—The general biological features of plants and the outlines of the evolution of plant types are considered; special attention being given to the significance of morphological characters and the forces operative in their development. Two lectures and four hours laboratory a week. Dr. CURTIS

2—Comparative Morphology of Plants—Involving field work on adaptation of structure to physical conditions. 2 laboratory sessions a week, first half-year. Dr. CURTIS

3—Plant Physiology—A course in experimental physiology supplemented by selected readings and conferences. Two laboratory sessions a week, first half-year. Dr. CURTIS

NOTE.—In this and other courses in vegetable physiology the nature of the work occasionally requires attendance at the laboratory at unusual times.

4—General Morphology of Cryptogams—Detailed study of some group or groups of the lower plants. Two laboratory sessions a week, second half-year. Mr. HOUSE

5—Botanical Problems—Illustrating advanced methods of fixing, imbedding, sectioning, and staining. Two laboratory sessions a week, second half-year. Dr. CURTIS

6—Economic Botany—Study of plants useful to man in the arts or as food, medicine, timber, and fibre. Two lectures, or the equivalent in the laboratory. Professor UNDERWOOD

7—Plant Physiology—A continuation of Course 3. One lecture and two laboratory sessions, second half-year. Dr. CURTIS

8—General Botany—A brief systematic study of plant structure and function, and the characters and relations of the leading groups of plants. Two lectures and laboratory work, first half-year. (For Civil Engineers only.) Professor UNDERWOOD and Mr. HOUSE

Barnard College

Botany 51—Elementary Botany—Five hours, lectures, demonstrations, and laboratory work. Professor RICHARDS
M., W., and F. at 9.30.

Botany 52—General Morphology and Development of Plants—Two lectures, four hours of laboratory work.

Two additional hours of laboratory work may be taken, in which case **Botany 52** will count as five points.

Tu. and Th. at 10.30.

Course 52 should be preceded by 51, but is open, on consultation with the instructors, to students of sufficient training who also either attend the lectures in 51 or elect the full six hours of laboratory work in Course 52.

Botany 53—Morphology and Ecology of Phanerogams—With practice in determination of species. Four hours.

Open to students that have taken, or are taking, Course 51.

Botany 54—Anatomy of Vascular Plants—Two lectures and a minimum of six hours of laboratory work, first half-year. Professor RICHARDS

55a—Physiology of Plants from Standpoint of Nutrition—Two lectures and a minimum of six hours of laboratory work. Alternate second half-years. Professor RICHARDS

[55b—Physiology of Plants from Standpoint of Growth—Two lectures and a minimum of six hours of laboratory work. Alternate second half-years. Professor RICHARDS

Not given 1903-1904.]

Courses 54, 55a, and 55b presuppose a knowledge of the more elementary courses.

Open to students only after consultation with the instructor.

56—Structure and Development of Algæ—Advanced course: half-year. One lecture, six hours of laboratory work. Professor RICHARDS

Open to students that have taken Courses 51 and 52.

57—Structure and Development of Fungi—Advanced course: half-year. One lecture, six hours of laboratory work. Professor RICHARDS

Open to students that have taken Courses 51 and 52.

Courses 56 and 57 are given either the first or second half-year as required.

58—Developmental Anatomy—Practice in methods of technique: second half-year. Eight hours of laboratory work with occasional lectures and outside reading. Professor RICHARDS

Open to students who have taken Course 54. May be taken with Course 55a or 55b.

59—Advanced Physiology and Morphology—Written work, outside reading, and a minimum of eight hours of laboratory work. Work will be arranged to suit the needs of the students. Professor RICHARDS

Open, on consultation with the instructor, to students that have taken Courses 51, 52, 54, and 55a or b, or their equivalents.

Teachers College

Education 20—Theory and Practice of Teaching Nature Study in Graded and Ungraded Schools. Botany, first half-year. (See Teachers College Catalogue: **Biology**.) Professor LLOYD

Education 60—Theory and Practice of Teaching Biology in the

Secondary School—Botany, second half-year. (See Teachers College Catalogue: **Biology**.) Professor LLOYD

Education 120—Practicum in Botany and Zoölogy. Botany, second half-year. (See Teachers College Catalogue: **Biology**.) Professor LLOYD

Biology 1—Botany—Lectures, laboratory work, recitations, excursions for field work, and collateral reading. Coulter's *Plant Structures*. Professor LLOYD

Tu. and Th., 9.30–11.30. Laboratory fee, \$2.

This course includes:—general morphology of plants, both phanerogams and cryptogams; more detailed study of seeds and germination; general plant physiology; ecology, plants, and their environment.

Nature Study 10—Biology of Plants and Animals—Botany, second half-year. (See Teachers College Catalogue: **Nature Study**.) Professor LLOYD

Physiology

College of Physicians and Surgeons

Candidates for the degree of M.D. are required to take Course 3.

Courses 1, 2, 3, 4, 5, are not open to women nor to students of Columbia College, except in so far as Course 3 is required of Seniors who are taking their first year in medicine.

Candidates for the degree of A.M. may take Courses 1 and 2, or Courses 3 and 4, or Course 4 with a sufficient amount of prescribed reading, the particular combination of courses selected depending largely on the student's previous training.

Candidates for the degree of Ph.D. are expected to take during their first year Courses 1 and 2; during the first half of their second year, Course 4, with Course 3 or with a sufficient amount of prescribed reading; and during the second half of their second year Physiological Chemistry, Course 1.

Research—The laboratories are open for research, under the direction of their officers, to advanced workers.

1—General Physiology—Structure of protoplasm; physiology of the cell; physiological division of labor and evolution of special functions, irritability; contractility; phototaxis; geotaxis; chemotaxis; galvanotaxis; general principles of secretion; the nerve cell; the nerve impulse; reflex action; the germ cells. Lectures, one hour. Professor LEE

A partial major or minor for the degree of A.M. or of Ph.D. Usually combined with Course 2. Pre-requisite: either Physiology 6; or Zoölogy 2, or an equivalent; or the first year's work in medicine. Open to qualified candidates for the degree of M.D.

2—Laboratory Course in General Physiology—Five hours. Professor LEE and Dr. BURTON-OPITZ

A partial major or minor for the degree of A.M. or of Ph.D. Usually combined with Course 1. Pre-requisite: either Physiology 6; or Zoölogy 2, or an equivalent; or the first year's work in medicine. Open to qualified candidates for the degree of M.D.

3—The Physiology of Man as Related to that of Other Mammals and of Lower Vertebrates—Lectures and demonstrations, four hours; laboratory work, three hours; recitations, one hour. Professors CURTIS and LEE, Drs. BURTON-OPITZ, EMERSON, COCHRAN, and SHEARER

A partial major or minor for the degree of A.M. or of Ph.D. Required of candidates for the degree of M.D. in the second half of the first year and the first half of the second year.

4—Laboratory Course in Special Physiology—Three hours. Given with the coöperation of the Department of Physiological Chemistry. Professors CURTIS, LEE, and GIES, and assistants.

A partial major or minor for the degree of A.M. or of Ph.D. Open to qualified candidates for the degree of M.D.

5—Electro-physiology—Hours and work to be arranged with the instructor. Dr. CUNNINGHAM

Columbia College

6—Elementary Physiology—Given with the coöperation of the Department of Physiological Chemistry. One hour lecture, and two hours laboratory work. 516 S. Professors LEE and GIES and Dr. BURTON-OPITZ

Open to Juniors and Seniors in Columbia College.

Department of Botany

The following courses deal with **Plant Physiology** and are given detailed reference under the Department of Botany, pp. 17-23. They include Courses Nos. 3 and 7, General Plant Physiology (Dr. CURTIS), 12, Advanced Physiology (Dr. CURTIS and Dr. MACDOUGAL), 16, Plant Cell (Dr. MACDOUGAL), 27, Plant Nutrition (Professor RICHARDS), 28, Ecological Physiology (Dr. CURTIS and Dr. MACDOUGAL), and 27, Physiological Anatomy (Dr. CURTIS).

Barnard College

A course in general **Animal Physiology** is given by the Department of Zoölogy of Barnard College, supplementing the work in general Biology and Zoölogy. (See p. 32.) Professor CRAMPTON and Mr. KELICOTT

Three courses in **Plant Physiology** are given by the Department of Botany of Barnard College (see p. 21.): One dealing with Plant Nutrition, **Botany 55a**, a second with Growth, **Botany 55b**, a third with advanced Physiology and Growth, **Botany 59**. All given by Professor RICHARDS

Teachers College

A course in elementary **Animal Physiology** is given during the first

half of the second half-year by Professor BIGELOW. (See Teachers' College Catalogue: **Education 20**.) A second course in **Animal Physiology** is given during the first half-year by Professor BIGELOW in coöperation with Professor LLOYD. (See Teachers College Catalogue: **Biology and Physical Education 3**.) See also a course in **Biology of Plants and Animals**, in the same catalogue, **Nature Study 10**; also an elementary summer course, in Summer Session Announcement, **s5**.

Physiological Chemistry

No previous work in physiological chemistry is necessary before a student may undertake graduate study in this department. Students who have passed courses in elementary chemistry, physics, physiology, and zoölogy may commence work in physiological chemistry for the degree of A.M. or Ph.D. Courses in other departments, or their equivalents, that are necessary in the preparation for Course 1, and for subsequent work for the A.M. or the Ph.D. degree are: (a) either Course 1 or 2 in general inorganic chemistry and Course 20 in elementary organic chemistry; (b) one year's work in physiology, Course 3; (c) Course 2 in elementary zoölogy; (d) Course 31 in general physics.

Candidates for the degree of A.M. may take Course 1 during the first half-year and Course 2 during the second half-year. Candidates for the degree of Ph.D. may take each of the courses in its natural order. Course 1 or its equivalent is the necessary preliminary to advanced work in physiological chemistry.

In addition to the courses announced below, this department co-operates with the department of Physiology as indicated on page 23. See, also, the announcement of the Division of Chemistry.

Courses

1—General Physiological Chemistry. This course is given twice during the year. The student is required to attend each week one lecture (one hour), one conference and recitation (one hour), and three laboratory exercises, including frequent demonstrations (two hours each).

The course embraces a chemical study of the cell and the whole organism, of nutrition, and of reproduction. The conferences and recitations are so conducted as to review and enlarge upon the results of the laboratory work and demonstrations. Among the various subjects considered experimentally are digestion and absorption, respiration, the blood, the tissues, excretions, milk, etc. The lectures are devoted mainly to such topics of a general nature as cannot well be brought up in the laboratory for direct experimentation in the time allowed for the course. Among the themes considered in the lectures are "The general nature of the chemical and physico-chemical processes in the body," "The chemical defences of the organism against

disease," "The influence of drugs, environment, etc., on the chemical changes in the organism," etc. In this treatment of chemical physiology the attention of the student is also directed from time to time to various related facts of a chemico-pathological character.

Lecture. Weekly (entire class), one hour. Professor GIES

Conference and recitation. Weekly (each section), one hour. Professor GIES

Laboratory exercises, including frequent demonstrations. Three per week (each section), two hours each. Professor GIES and Drs. RICHARDS and HAWK

Required in the second year of all candidates for the degree of M.D. Open, as an elective, to qualified Seniors in the College and to candidates for the degree of A.M. or Ph.D.

A partial minor or major for the degree of A.M. or Ph.D.

2—Laboratory Course in Advanced Physiological Chemistry, Including a Study of Clinical Methods. This course is a continuation of Course 1, but gives more detailed instruction in the various subjects belonging to physiological chemistry than the time for Course 1 will allow. Six hours. Professor GIES and Dr. RICHARDS

Pre-requisite: Course 1 or its equivalent.

A partial minor or major for the degree of A.M. or Ph.D.

3—Laboratory Course in Special Physiological Chemistry. This course is arranged for students who wish to make a very thorough study of the science. It particularly affords opportunity for experimental observations of the more intricate phases of chemical physiology and terminates in original investigation under personal direction. Twelve hours. Professor GIES and Dr. HAWK

Pre-requisite: Courses 1 and 2 or their equivalents.

A partial minor or major for the degree of A.M. or Ph.D.

4—Physiological Chemistry of Plants, Including a Study of Laboratory Methods. This course is arranged for the benefit of students of botany and of materia medica. The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is Consulting Chemist. Six hours. Professor GIES

Pre-requisite: Course 1 or its equivalent.

A partial minor or major for the degree of A.M. or Ph.D.

Research

The laboratory is open to advanced workers for research.

Zoölogy

Courses in the University

The courses in this department leading to the degrees of A.M. and Ph.D. require in general as pre-requisites two years of preparatory work, equivalent to Courses 2 (Elementary Biology) and 3 (General Zoölogy). Under certain conditions, stated below, Course 3 may, however, count towards the A.M. and Ph.D. degrees. The following re-

quirements, given as a guide to students, are subject to modification in special cases.

For the A.M. degree a major course requires the equivalent of two one-day courses for one year; examples, Course 5 (a two-days course), Courses 4 and 8 (one-day courses), or any one of Courses 4, 8, 13, 18, 20 (one-day courses), with any two of Courses 6, 7, 9, 10, 19, 21, 22, 23, (half-year one-day courses). A minor is approximately one-half the major. Students who have not taken Course 3 as undergraduates may take this as the equivalent of a minor course.

For the Ph.D. degree a major requires as a minimum the equivalent of two one-day courses for two years in addition to research. Course 5 is recommended to all graduate students as a general foundation-course. For a minor, Course 3 (or its equivalent) may constitute one-half the requirement in the case only of students who have not taken this course as undergraduates; the remaining half comprises any one of the full-year courses, 4, 5, 8, 13, 18, 20, or any two of the half-year courses, 6, 7, 9, 10, 19, 21, 22, 23. Where students have been able to take Course 3 as undergraduate work, a minor comprises, in addition, the equivalent of the A.M. major as specified above.

The lectures of Courses 4, 5, 6, 7, 8, 9, 9a, 10, 13, 14, 15, 18, 19, 20, and 22, are open to women. The corresponding laboratory work for women students is for the most part conducted at Barnard College. Courses 2 and 3 are given separately at Barnard.

Courses Leading to the Degrees of Master of Arts and Doctor of Philosophy

3—General Zoölogy—Vertebrate and invertebrate zoölogy, anatomy, embryology, and etiology (natural environment, terrestrial and marine faunal areas, principles of distribution).

(a)—Comparative morphology, classification, and general zoölogy of invertebrates. Text-book: Parker and Haswell, *Zoölogy*, Vol. I. Professor CALKINS. 619 S.

Three lectures and six hours laboratory work during the first half-year.

(b)—Classification and comparative anatomy of the main living orders of fishes, amphibians, reptiles, birds, and mammals. Practical study of the skeleton, integument, muscles, nerves, viscera. Text-book: Parker and Haswell, *Zoölogy*, Vol. II. Professor DEAN and Dr. MCGREGOR. 619 S.

Two lectures and four hours laboratory work during the second half-year.

(c)—Embryology (vertebrates). An examination of the characteristic stages of fishes, amphibians, reptiles, birds, and mammals. Embryological technique. Text-book: Mark's Hertwig's *Vertebrate Embryology*. Professor DEAN and Dr. MCGREGOR. 619 S.

One lecture and two hours laboratory work during the second half-year.

(d)—Mammalian dissection. Detailed practical study of a mammal with practice in technique. Optional with (a) for preparatory medical students. Dr. MCGREGOR. 619 S.

Text-books: Wiedersheim's *Comparative Anatomy*; Parker's *Zoötomie*; Parker and Haswell's *Zoölogy*; Mark's Hertwig's *Embryology*.

Open to Seniors in Columbia College and graduates. The course in elementary biology (2) is a pre-requisite. Students who have previously taken only the shorter course (2—a, b, d) will be required to make up the work included in Courses 2c, 2e, but the latter will not be considered as a partial equivalent for graduate courses. The embryology, 3 b, may be taken as an elective.

(See Courses in Barnard College, *infra*.)

4—Comparative Neurology—An introduction to the comparative structure of the brain and nervous system of the lower and higher animals. The anatomy of the brain, spinal cord, and nerves in amphioxus, fishes, amphibians, reptiles, birds, and mammals. Training in the Weigert, Golgi, and other technical methods. Edinger's *Twelve Lectures upon the Nervous System*; Gaupp's *Anatomie des Frosches*, Abth. ii., erste Hälfte; also the text-books of Wiedersheim and Gegenbaur and the works of Golgi, Cajal, Lenhossék, and others. Dr. STRONG

Open to Seniors in Columbia College and graduates. One lecture and at least four hours laboratory work a week throughout the year. A shorter supplementary course may be offered when desired to supply a more thorough training in neurological technique.

5—Comparative Zoölogy—This course is a continuation of Courses 2 and 3. General anatomy and development of vertebrates and invertebrates, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work. Ten hours (two days) a week. The first term is devoted to the invertebrates (Professors WILSON and CALKINS); the second term to the vertebrates (Professor OSBORN and Dr. MCGREGOR). Sedgwick's *Text-book of Zoölogy*, Lang's *Comparative Anatomy*, Korschelt-Heider's *Text-book of Embryology*, Wiedersheim's *Grundriss der Vergleichenden Anatomie der Wirbelthiere*, Gegenbaur's *Vergleichende Anatomie*, Woodward's *Palæontology*. Special works, monographs, and papers are extensively used in this course.

6—Comparative Embryology—A comparative treatment of the earlier stages of development, with especial reference to general problems. One lecture a week with reading, conferences, and specially arranged laboratory work through the second half-year. Course 18 forms a desirable preparation or accompaniment. Professor WILSON

7—Cellular Biology—General structure and functions of the cell. Six hours (one day) a week through the second half-year. Reference books: Wilson, *The Cell*; Hertwig, *The Cell*; Henneguy, *Leçons sur la Cellule*. Professor WILSON

8—Mammals, Living and Fossil—A study of the structure, evolution, and classification of the mammalia. Lecture and laboratory course. Reference books: Flower's *Osteology*; Flower and Lydekker's

Mammals; Zittel's *Palæontologie*. Six hours (one day) a week throughout the year. Professor OSBORN

The latter part of this course is given in the American Museum of Natural History.

9—Fishes, Living and Fossil. This course, considers especially the phylogenetic relations of the sub-classes and orders of fishes. Reference books: Smith Woodward, *Catalogue of Fossil Fishes*, Günther, *Study of Fishes*; and Dean, *Fishes, Living and Fossil*. One lecture a week with demonstrations during the first half-year. Professor DEAN

10—Special Morphology: the Protozoa—A general treatment of the classification, morphology, and physiology of this type of organisms, and of their relations to modern theories of biology. One lecture and two hours laboratory work a week during second half-year. Reference books: Butschli, *Protozoa*, in Bronn's *Thierreich*; Calkins, *The Protozoa*; Lang, *Protozoa*. Professor CALKINS

11—Advanced Biology—Individual study of special groups of animals or of special biological problems as an introduction to original investigation. The time varies in different cases.

13—The Human Brain and Spinal Cord—This course includes a study of both macroscopic and microscopic structure, supplemented wherever necessary by references to the structure of the nervous systems of lower forms. It naturally follows 4, but may be taken separately. Lecture and four hours laboratory work a week throughout the year. Reference books: The text-books of Etinger, Schäfer, Obersteiner, Déjerine, van Gehuchten, Kölliker, and Barker. Dr. STRONG

Open to graduates and to Seniors as an alternative to Course 4.

15—Sanitary Biology—A general course covering the main principles of zoölogy as they apply to microscopic organisms. The Protozoa and other microscopic forms in their relations to odors, tastes, and appearances in drinking-waters. Methods and results. Selected readings. Lecture and laboratory work. Three hours, during the first half-year. Professor CALKINS.

Designed for students in Civil Engineering, Sanitary Science, and Chemistry.

16—Practical Histology—Practical comparative study of the tissues and organs, with especial reference to histological technique. This course forms a supplement to Course 3, but may be taken separately. It is intended as partial preparation for subsequent work in medicine or biology.

Open to Seniors in Columbia College and graduates who have taken Course 2 (longer course) or an equivalent. One class exercise and two hours laboratory work a week throughout the year. Tu., 2.30 P.M.

17—Practical Embryology—Detailed comparative study of the development especially of vertebrates, with particular reference to embryological technique. Like Course 16 this supplements Course 3, but may be taken separately or with Course 16.

Open to Seniors in Columbia College and graduates under the same conditions as Course 16. One class exercise and two hours laboratory work a week throughout the year. Th., 2.30 P.M.

18—Comparative Embryology—Facts and principles of animal development, with especial reference to comparative organogeny in vertebrates and invertebrates. The major part of the laboratory work is devoted to the practical study of the main vertebrate types. Embryological technique, one day a week throughout the year. General reference works: Hertwig, *Handbuch der Entwicklungslehre der Wirbeltiere*; Korschelt and Heider, *Text-book of Embryology*; Balfour, *Comparative Embryology*; Ziegler, *Entwicklungsgeschichte*. Professors DEAN and CALKINS

19—The Protochordates—A study of the morphology and embryology of the protochordate groups and allied forms, with special reference to their phylogenetic relationships and to the problems of vertebrate descent. Lecture and laboratory work, one day a week during the first half-year. References: Willey, *Amphioxus and the Ancestry of the Vertebrates*; Delage and Hérouard, *Zoologie Concrète*, Tome 8, *Les Procordés*, and special monographs and papers. Dr. MCGREGOR

20—The Statistical Study of Variation (given in coöperation with the Department of Anthropology)—Lectures, essays, discussions, and laboratory work. This course is intended as an introduction to the study of variation for students of zoölogy, botany, anthropology, and psychology. The characteristic features of variability and methods of treatment are discussed, with practical work upon special problems in the laboratory. Two lectures (Professor BOAS) and two hours of laboratory work (Professors BOAS and CRAMPTON). See *Anthropology* 2 and 8

21—Experimental and Physiological Morphology—A review of recent work in the fields of developmental mechanics, regeneration and related topics, with readings and conferences. One lecture a week during the first half-year. Reference books: Wilson, *The Cell*; Morgan, *Development of the Frog*; Davenport, *Experimental Morphology*; Verworn, *General Physiology*; Morgan, *Regeneration*; Korschelt and Heider, *Embryology*, General Part. Professor CRAMPTON

22—The Enterocœla (exclusive of the Protochordates)—A detailed study of the morphology and embryology of the Prosopygia and Echinoderma, as the basis for a critical examination of the phylogenetic relationships of these groups to other invertebrate as well as to the protochordate divisions. One lecture and five hours laboratory work (one day) a week, throughout the second half-year.

Reference books: Lang, *Text-book of Comparative Anatomy*, Delage, *Zoologie Concrète*; Korschelt and Heider, *Text-book of Embryology*, together with special monographs. Professor CRAMPTON

23—Sense Organs of Invertebrates—The comparative morphology and physiology of primitive organs of sight, hearing, taste, etc. One lecture with demonstrations and selected reading throughout the second half-year. Professor CALKINS

Courses in Columbia College

2—Elementary Biology (zoölogy)—Introductory to morphology and physiology and to the general principles of biology.

This work is arranged in a longer and a shorter course, consisting of three and two exercises a week respectively. The shorter course omits the work in histology and embryology. In this course a detailed study of a series of living forms is made the basis for brief discussions of essential principles.

First Half-Year

(a)—**General Biology**—Two exercises a week throughout the first quarter-year. General introduction. Protoplasm and the cell. Biology of the earth-worm and the fern. Unicellular organisms: *Amœba*, *pleurococcus*, yeast, bacteria, infusoria. *Hydra*, hydroids. Professors WILSON and CALKINS. 619 S.

(b)—**Elementary Zoölogy (invertebrates)**—Two exercises a week throughout the second quarter-year. The earth-worm, lobster, crab, insect, mussel, starfish, ascidian, and other types. Professor CALKINS and Dr. MCGREGOR. 619 S.

(c)—**Elementary Histology (longer course)**—One exercise a week throughout the half-year. General study of animal cells and tissues. Dr. MCGREGOR. 619 S.

Second Half-Year

(d)—**Elementary Zoölogy (vertebrates)**—Two exercises a week. The lancelet, dogfish, frog, pigeon, and rabbit. In addition the main problems of evolution and heredity are briefly explained. Professor DEAN and Dr. MCGREGOR. 619 S.

(e)—**Elementary Embryology (longer course)**. One exercise a week. Development of the frog and chick. Dr. MCGREGOR. 619 S.

Text-books: Sedgwick and Wilson's *General Biology*, Marshall and Hurst's *Practical Zoölogy*. Reference books: Parker's *Elementary Biology*, Jordan and Kellogg's *Animal Life*, Osborn's *Greeks to Darwin*; Marshall's *Vertebrate Embryology*.

Open to Juniors and Seniors in Columbia College. Two or three lectures and four or six hours laboratory work throughout the year.

Courses in Barnard College

2—Elementary Biology and Zoölogy—Professor CRAMPTON, Mr. KELLICOTT, Miss DEDERER

(a)—**General Biology and General Zoölogy**. Two lectures and four hours of laboratory work.

(b)—**General Biology and General Zoölogy**, as defined above, together with one lecture and two hours of laboratory work in embryology during the second term.

(c)—**General Biology and General Zoölogy**, as defined above, together with one lecture and two hours of laboratory work throughout the year (histology and physiology first term, embryology second term).

Tu. and Th. at 1.30. Laboratory work in biology and zoölogy, 2.30-5.30. Tu. and Th. Hours for histology and physiology, and embryology to be arranged. Laboratory fee, \$5.

Open to Juniors and Seniors; especially designed for students that have taken Physics 1, Chemistry 1, and Botany 51.

This course is designed for students of psychology, physiology, geology, and medicine, as well as for those who intend to pursue zoölogy and botany.

3—General Zoölogy—Advanced course. Professor CRAMPTON, Mr. KELLICOTT, and Miss DEDERER. Three lectures, six hours of laboratory work.

Hours to be arranged. Laboratory fee, \$5.

Open to students that have taken Zoölogy 2 or its equivalent (Seniors and Graduates.)

This course is designed for students intending to enter medicine, also for students of zoölogy and botany, as graduate subjects.

51—General Physiology—Professor CRAMPTON, Mr. KELLICOTT. General principles of animal physiology and histology. Two lectures, and four hours of demonstrations and laboratory work.

Hours to be arranged. Laboratory fee, \$5.

Open to Juniors and Seniors.

This course is designed for students of zoölogy, botany, and psychology, as well as for students intending to study medicine, and may be taken together with, or subsequent to, Zoölogy 2.

Courses in Teachers College

Education 20—Theory and Practice of Teaching Nature Study in the Elementary School. Zoölogy, last half second half-year. (See Teachers College Catalogue: **Biology**.) Professor BIGELOW

Education 60—Theory and Practice of Teaching Botany and Zoölogy in the Secondary Schools. Zoölogy, first half-year. (See Teachers College Announcement: **Biology**) Professor BIGELOW

Education 120—Practicum in Botany and Zoölogy. Zoölogy, first half-year. (See Teachers College Catalogue: **Biology**) Professor BIGELOW

Biology 2—Zoölogy. Lectures, laboratory work, and collateral reading, with recitations. Professor BIGELOW

W. and F., 1.30-3.30. Laboratory fee, \$2.

This course deals with the general principles of zoölogy, morphological as well as physiological, and includes the study of a series of types of animals, both invertebrate and vertebrate. Parker's *Practical Zoölogy*.

Nature Study 10—Biology of Plants and Animals. Zoölogy, first half-year. (See Teachers College Catalogue: **Nature Study, Zoölogy**.) Professor BIGELOW

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Seventh Series, No. 26

July 13, 1907



Columbia University Bulletin of Information

DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PHYSIOLOGY, ZOÖLOGY

ANNOUNCEMENT

1907-1909

Published by
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Columbia University
Bulletin of Information

(Issued 25 times during the Academic year, monthly in November and December, and weekly between February and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under Act of July 16, 1894.)

These include :

1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, issued in December, price 25 cents.
3. The Announcements of the several Colleges and Schools and of certain Divisions, issued in the Spring and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University. For information as to the various courses offered by the University consult the last page of this Announcement.

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ABRIDGED ACADEMIC CALENDAR

The Academic year is thirty-seven weeks in length, ending on the Wednesday nearest the 11th of June. In 1907-08 the year begins on September 25, 1907, and ends on June 10, 1908. It is divided into two half-years of fifteen weeks of instruction each. In 1907-08 the second half-year begins on February 3, 1908. The Summer Session for 1907 begins on July 9 and ends on August 17.

The exercises of the University are suspended on Election Day, Thanksgiving Day, and the following two days, for two weeks at Christmas, on Washington's Birthday, from the Thursday before Good Friday through the following Monday, and on Memorial Day.

The complete Academic Calendar will be found in the University catalogue and so far as it refers to the students studying under any Faculty, in the announcement of that Faculty.

OFFICERS OF THE DIVISION OF BIOLOGY

Professor JOHN G. CURTIS, *Chairman*

Professor HERBERT M. RICHARDS, *Secretary*

JOHN G. CURTIS, M.D., LL.D.....	<i>Professor of Physiology</i>
GEORGE S. HUNTINGTON, M.D., ScD., LL.D....	<i>Professor of Anatomy</i>
HENRY FAIRFIELD OSBORN, ScD., LL.D..	<i>Da Costa Professor of Zoölogy</i>
EDMUND B. WILSON, Ph.D., LL.D.....	<i>Professor of Zoölogy</i>
T. MITCHELL PRUDDEN, M.D., LL.D.....	<i>Professor of Pathology</i>
FREDERIC S. LEE, Ph.D.....	<i>Professor of Physiology</i>
BASHFORD DEAN, Ph.D.....	<i>Professor of Vertebrate Zoölogy</i>
LUCIEN MARCUS UNDERWOOD, Ph.D., LL.D..	<i>Torry Professor of Botany</i>
HENRY E. CRAMPTON, Ph.D.....	<i>Professor of Zoölogy</i>
WILLIAM J. GIES, M.S., Ph.D.....	<i>Professor of Biological Chemistry</i>
HERBERT MAULE RICHARDS, Sc.D.....	<i>Professor of Botany</i>
GARY N. CALKINS, Ph.D.....	<i>Professor of Protozoölogy</i>
PHILIP HANSON HISS, JR., M.D.....	<i>Professor of Bacteriology</i>
MAURICE A. BIGELOW, Ph.D..	<i>Professor of Biology in Teachers College</i>
RUSSELL BURTON-OPITZ, M.D., M.S..	<i>Adjunct Professor of Physiology</i>
THOMAS H. MORGAN, Ph.D.....	<i>Professor of Experimental Zoölogy</i>
BERN B. GALLAUDET, M.D.....	<i>Adjunct Professor of Anatomy and</i> <i>Clinical Lecturer and Instructor in Surgery</i>
JAMES H. MCGREGOR, Ph.D.....	<i>Adjunct Professor of Zoölogy</i>
EDWARD LEAMING, M.D.....	<i>Instructor in Photography</i>
RICHARD HOOP CUNNINGHAM, M.D..	<i>Instructor in Electro-Physiology</i> <i>and in Neurology</i>
OLIVER S. STRONG, Ph.D....	<i>Instructor in Histology and Embryology</i>
ALFRED NEWTON RICHARDS, Ph.D.....	<i>Instructor in Pharmacology</i>
AUGUSTUS B. WADSWORTH, M.D.....	<i>Instructor in Bacteriology</i>
CARLTON C. CURTIS, Ph.D.....	<i>Instructor in Botany</i>
NELLIS B. FOSTER, M.D.....	<i>Instructor in Biological Chemistry</i>
TRACY E. HAZEN, Ph.D.....	<i>Instructor in Botany</i>
RAYMOND C. OSBURN, Ph.D.....	<i>Instructor in Zoölogy</i>
JEAN BROADHURST, B.S.....	<i>Instructor in Biology in Teachers College</i>
HENRY E. HALE, M.D.....	<i>Demonstrator of Anatomy</i>
HAVEN EMERSON, M.D.....	<i>Demonstrator of Physiology</i>
WILLIAM DARRACH, M.D.....	<i>Demonstrator of Anatomy</i>
LEANDER HOWARD SHEARER, M.D.....	<i>Demonstrator of Physiology</i>
ARTHUR W. BINGHAM, M.D.....	<i>Demonstrator of Physiology</i>
C. R. L. PUTNAM, M.D.....	<i>Demonstrator of Anatomy</i>
H. v. W. SCHULTE, M.D.....	<i>Demonstrator of Anatomy</i>
HARRY M. KEATOR, M.D.....	<i>Demonstrator of Physiology</i>

F. T. VAN BEUREN, M.D.....	<i>Demonstrator of Anatomy</i>
JOSEPH G. YOCUM, M.D.....	<i>Demonstrator of Physiology</i>
GUSTAVE M. MEYER, Ph.D.....	<i>Tutor in Biological Chemistry</i>
MARGARET A. REED, A.B.....	<i>Tutor in Zoölogy</i>
PAULINE H. DEDERER, A.B.....	<i>Tutor in Zoölogy</i>
WILLIAM N. BERG, B.S.....	<i>Tutor in Biological Chemistry</i>
MARION E. LATHAM, A.M.....	<i>Tutor in Botany</i>
ROLFE FLOYD, M.D.....	<i>Lecturer in Anatomy</i>
WILLIAM K. GREGORY, Ph.D.....	<i>Lecturer in Zoölogy</i>
WILLIAM H. WELKER, B.S.....	<i>Assistant in Biological Chemistry</i>
HANS ZINSSER, A.M., M.D.....	<i>Assistant in Bacteriology and Hygiene</i>
CHARLES V. MORRILL, JR., A.M.....	<i>Assistant in Zoölogy</i>
ELIZABETH I. THOMPSON, A.B.....	<i>Assistant in Botany</i>
CHESTER A. DARLING, A.M.....	<i>Assistant in Botany</i>
DAVID G. ALLEN, M.D.....	<i>Assistant in Bacteriology and Hygiene</i>

MEMBERS OF THE STAFF OF THE BOTANICAL GARDEN GIVING INSTRUCTION IN THE DIVISION

NATHANIEL LORD BRITTON, Ph.D., Sc.D.....	<i>Director and Emeritus Professor of Botany</i>
WILLIAM ALPHONSO MURRILL, Ph.D.....	<i>First Assistant</i>
CHARLES STUART GAGER, Ph.D.....	<i>Director of the Laboratories</i>
JOHN KUNKEL SMALL, Ph.D.....	<i>Head Curator of the Museums</i>
PER AXEL RYDBERG, Ph.D.....	<i>Curator</i>
ARTHUR HOLLICK, Ph.D.....	<i>Curator</i>
MARSHALL AVERY HOWE, Ph.D.....	<i>Curator</i>
GEORGE VALENTINE NASH.....	<i>Curator of the Plantations</i>
HENRY HURD RUSBY, M.D.....	<i>Curator of Economic Collections</i>
<i>Partial Courses are also Given by</i>	
ELIZABETH GERTRUDE BRITTON	
EDWARD SANFORD BURGESS, Ph.D.	

GENERAL STATEMENT

INTRODUCTORY

The Division of Biology includes the departments of Anatomy, Bacteriology, Botany, Physiology, Biological Chemistry, and Zoölogy in all schools of the University. The present announcement is therefore designed to give under separate headings a list of all biological courses, whether in Columbia College, the School of Pure Science, the College of Physicians and Surgeons, Barnard College, or Teachers College.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those granted to men.

Students are received as candidates for the degrees of Master of Arts and Doctor of Philosophy under the Faculty of Pure Science; for the degrees of Bachelor of Arts and Bachelor of Science either in Columbia College or in Barnard College; and for the degree of Bachelor of Science in Teachers College. They are also permitted to pursue special or partial courses subject to the regulations of the Faculty under which they may register.

Certain courses which may be counted toward the several degrees are also offered in the Summer Session of the University.

The Degrees of M.A. and Ph.D.

Candidates for the degrees of Master of Arts and Doctor of Philosophy must hold a baccalaureate degree in arts, letters, philosophy, or science, or an engineering degree, or an equivalent of one of these from a foreign institution of learning. Every candidate for a higher degree must present to the Dean of each school in which he intends to study satisfactory evidence that he is qualified for the studies he desires to undertake.

Candidates must pursue their studies in residence for a minimum period of one and two years, respectively. The complete regulations will be found in the *Announcement of the Faculties of Political Science, Philosophy, and Pure Science*. This Announcement contains also a detailed statement as to the election of major and minor subjects, and an estimate of the amount of time necessary for their completion.

In practice, three years of study are usually necessary to obtain the degree of Doctor of Philosophy.

Attention is called to the pamphlet entitled *Instruction for Graduate Students Leading to the Degrees of Master of Arts and Doctor of Philosophy*, which may be had on application to the Secretary of the University, and particularly to the fact that the requirements for the higher degrees are based upon subjects and not upon courses. Students who wish to offer a subject, either as a major or minor, should, before registration, consult the officers of instruction concerned with regard to their selection of courses. Hours for consultation are appointed, which may be learned by reference to the general catalogue or by application to the Secretary of the University, Room 213.

The following special regulations of the Faculty of Pure Science should have the attention of students under that Faculty.

The student is expected to gain a sound general knowledge of the two minor subjects of his choice. In the major subject a much more thorough and special knowledge is required, particular importance being attached to training in research. In the School of Pure Science, how-

ever, two subjects can be chosen in the same department only by special vote of the Faculty. By this means undue specialization can be controlled.

The approval of the subject of the dissertation required for the degree of Master of Arts or of Doctor of Philosophy rests with the instructor in charge of the candidate's major subject. It is desirable that the studies upon which a dissertation is based should be related, and when practicable, that they should be treated respectively as preliminary and completed investigations. Great importance is attached to the character of the final dissertation. While it must depend for acceptance chiefly on the subject-matter, it should show good literary workmanship, especially by directness and clearness of statement. It should demonstrate the author's capacity to do original scientific work and to render an intelligible account thereof. It should evince a familiarity with the literature of the subject and with the latest methods of research. The treatment should be as concise as the nature of the work permits. Every dissertation should be preceded by a clear introductory statement, setting forth the nature and the scope of the research, and be followed by a summary of the results and the conclusions obtained. It should also be accompanied by a table of contents and by a list of the authorities consulted in its preparation.

Complete details as to the administrative regulations of the University and as to the privileges offered to its students will be found either in the University catalogue or in the *Announcements* of the several Faculties.

Fellowships and Scholarships

Columbia University expends nearly \$75,000 annually in assisting deserving students. There are twelve University Fellowships, of an annual value of \$650 each, and in addition three specially endowed fellowships open to advanced students in biological research; thirty-two University Scholarships, including four open to women, of an annual value of \$150 each, available for students under the Faculty of Pure Science; and numerous scholarships for undergraduates in Columbia College, Barnard College, and Teachers College. There is a special scholarship in biology amounting to \$200 awarded annually by the Wavepex Society. This includes the use of a biological table at Cold Spring Harbor, Long Island.

The regulations governing the award of fellowships and scholarships will be found in the appropriate University bulletins to which reference has already been made, and the blank forms of application may be obtained from the Secretary of the University. Applications should be filed for fellowships not later than March first; for scholarships, not later than May first.

Funds and Prizes

Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open therefore to students of the Division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

The University maintains Committees on Employment for Students and on Appointment. Through the former, deserving and competent students are enabled to obtain work, either during the academic year or in the summer vacation, which will help them to defray their expenses while at the University; through the latter, assistance is offered to graduates to obtain suitable permanent positions. Communications should be addressed to the Committee in each case.

Residence Halls

There is a University Commons and Residence Halls with provision for 500 men. There are also Dormitories for women. A special pamphlet with regard to these halls may be had upon application.

ORGANIZATION AND EQUIPMENT

Anatomy

The laboratory for advanced morphological research occupies the third story of the Anatomical Building. Every facility for advanced and research work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology

The work in Bacteriology is conducted in a special section of the northern wing of the College of Physicians and Surgeons in the Department of Pathology. The laboratories for the morphological and biological study of micro-organisms are suitably equipped, and the systematic study is greatly facilitated by the maintenance of the large collection of the known forms of bacteria under cultivation. The facilities for work in photomicrography, which are maintained in connection with the Department of Pathology, are accessible to workers in bacteriology.

Biological Chemistry

The Department of Biological Chemistry possesses six well-equipped rooms for experimental work. Two of these are relatively large and will each accommodate about seventy workers at a time. Four smaller rooms are specially fitted up for original investigations by advanced students.

A small laboratory in Schermerhorn Hall has been equipped for research in biological chemistry to be carried out in co-operation with the Department of Zoölogy. Similar provision has been made in Fayerweather Hall for biochemical research in collaboration with workers in the Department of Physics.

Special facilities have been provided at the New York Zoölogical Park for research there in biological chemistry under the direction of the head of this department.

The laboratories of the New York Botanical Garden are open to students of biological chemistry.

Professor Gies's library is housed in the laboratory and is available at all times to all students in the University.

Botany

The Department of Botany occupies the third floor of Schermerhorn, and the laboratories and lecture-rooms are thoroughly equipped for undergraduate work. A large general laboratory, lecture-room, and morphological and physiological laboratories are supplied with modern instruments for instruction and experiment. A sufficient number of standard botanical works and serials on the subject are reserved for students' use in the general laboratory.

Similar opportunities for the work of women are offered in the laboratories at Barnard College.

Graduate courses are conducted at the Museum of the New York Botanical Garden. By the agreement entered into between the University and the Garden, all the botanical collections and library of the University (except such works as are needed in the undergraduate courses) have been deposited in the Museum of the Botanical Garden at Bronx Park; the Garden on its part supplies all needed facilities for research for members of the staff and for properly accredited students. This combination of forces not only places the department of Botany within reach of material equipment and collections not otherwise available, but opens up facilities for research work under conditions that are not excelled.

The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms,

photographic and balance room, laboratory for physiological chemistry, and sky-lighted apartment for living plants, which is furnished with a suitable aquarium. Ample opportunity for experimental work is afforded by the open-air plantations and extensive horticultural houses.

The Columbia herbarium and the equally extensive collections of the New York Botanical Garden are housed in the large room in the east wing of the Botanical Museum. The cryptogamic collections are arranged in special rooms. The entire aggregation of collections available for students is exceptionally full in every group of plants.

The portion of the University Library classified under Botany is deposited in the library stack-room of the Museum building, where it can be consulted in connection with the extensive supplementary collection now owned by the New York Botanical Garden. The combined libraries aggregate 20,000 volumes. All the regularly published journals devoted to Botany proper (over one hundred) are received, and the sets of all are complete.

One of the distinctive features of the graduate work is a weekly botanical convention held each Wednesday at 4.30 P.M., where members of the staff and students present either the results of their own work or review the progress of botanical research and publication elsewhere.

Physiology

At the College of Physicians and Surgeons there is a laboratory for research and the preparing of demonstrations, a small laboratory for histological research with special reference to physiological problems, and two rooms for optical or psychological work, or for photography. There are also two laboratories for practical instruction. In the Swift Physiological Cabinet, which is specially endowed, there is a very full collection of apparatus of precision, mainly for research.

In Schermerhorn Hall there is a laboratory equipped for the instruction of undergraduates.

The physiological journals are accessible to the students of the department; also the most important books, both modern and ancient.

A skilled mechanic is employed to devote his entire working time to the care and improvement of the plant, including the making, altering, and repairing of special apparatus. He also assists in the scientific manipulations.

Zoölogy

The zoölogical laboratories on the upper floor of Schermerhorn comprise a large general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoölogy, and eight rooms for private research, besides special rooms for supplies, aquaria, and preparation. There is also a commodious lecture-room, a library, and a seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the great collections of the American Museum of Natural History (see below) the department does not maintain a general zoölogical museum. The equipment includes, however, an extensive teaching collection of animals and anatomical preparations and an aquarium room in which charts and wax models, a variety of living animals and plants are kept.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, a part of the University library kept in the laboratory, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes the journals and a rapidly increasing collection of special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. Forty-three of the current biological journals are subscribed for. The valuable libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History, under the management of a board of trustees, now contains very extensive collections illustrating the zoölogy and palæontology of invertebrates and vertebrates, both from the systematic and bionomic point of view. The exhibition halls are always open to students, and certain of the University lectures and certain courses of research are conducted in the museum. Application should be made to Professor H. C. BUMPUS, Director.

The Zoölogical Park in the Borough of the Bronx, under the direction of the New York Zoölogical Society, affords exceptional opportunities for the study of living reptiles, birds, and mammals. The park is under the general direction of Director William T. Hornaday, to whom applications should be addressed. The birds are in charge of Mr. C. William Beebe, the reptiles and amphibians in charge of Mr. R. L. Ditmars. A biological laboratory is planned in connection with the hospital service of the park.

The New York Aquarium, also under the management of the Zoölogical Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a complete fish hatchery, which is in operation all the year round. Application should be made to Director Charles H. Townsend.

One of the special features of the department is the journal club, open to instructors and all advanced students, and meeting every week in the departmental library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

A weekly seminar open to all members of the department is usually

also carried on in the second half-year, for the more thorough discussion of some one selected topic of general interest.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, two investigators' rooms are subscribed for by the University for the use of the Departments of Zoölogy and Physiology; in the latter a table is available through the John D. Jones Scholarship. Circulars of the summer courses are obtainable in the department. In addition to the above facilities field-expeditions are from time to time sent out by the department.

Publications

The University Press issues the *Columbia University Biological Series*, a number of educational volumes originally founded upon public lectures, of which eight have already appeared and two others are in preparation. Another feature in advanced instruction is the connection with the biological section of the New York Academy of Sciences, which affords opportunities for reading, discussing, and printing scientific papers.

Two series of publications are issued from the Department of Botany: a quarto series known as the *Memoirs of the Department of Botany*, of which two volumes have been published; and the *Contributions from the Department of Botany*, in octavo, which have commenced on the tenth volume.

There are issued yearly *Studies from the Department of Pathology*, of which nine volumes have been published.

The *Columbia University Quarterly* contains each year reports of the work of the several departments in this division.

DEPARTMENTAL STATEMENTS OF COURSES

Introductory

The courses of instruction are numbered in accordance with a plan uniform throughout the University, and attention is called to the following information which the number assigned to a course will in each case indicate:

Odd numbers indicate the first, even numbers the second half of the academic year. Courses designated 1-2, 21-22, etc., run through both half-years. Courses numbered between 1 and 100 are, in general, elementary and may not be offered in fulfilment of the requirements for the higher degrees (A.M. and Ph.D.). Courses numbered from 101-200 are primarily for students who hold a first degree, but are open to undergraduates who have completed 72 points (for courses in law 94 points), including all prescribed work. In general no such

course may be taken without some elementary training in the same or in some allied subject. Courses from 201-300 are restricted to such graduate students as are qualified to pursue the work to advantage. Seminars are numbered from 301 up.

Courses enclosed in brackets are not offered during 1907-1908, and the instructor may withdraw any other course that is not applied for by at least three candidates for a degree.

Unless otherwise stated, the number of hours given indicates the hours of classroom work (lectures, conferences, and recitations) per week. When a course involves both classroom work and laboratory work the former will be indicated by *C* and the latter by *L* respectively. An "afternoon" implies three hours a day, normally from one to four.

ANATOMY

Courses 53-54, 55-56, 57, 58 and 66 are required in the first year of candidates for the degree of M.D. The four courses together may be elected by Seniors in Columbia College.

Courses 51-52, 59-60, 61-62, 63-64 and 65 are required in the second year of candidates for the degree of M.D.

Courses 117-118 and 149-150 are optional for qualified candidates for the degree of M.D. May be offered as a major or minor for the degree of A.M. or Ph.D. according to special arrangement with the head of the department.

51-52—Vertebrate Morphology—Anatomy of the body cavities—Visceral and topographical course—Thorax and abdomen. Lectures combined with demonstrations. Three hours. Professor HUNTINGTON.

53-54—Demonstrations—Cranial osteology, syndesmology, myology, peripheral nervous system, and angiology of the head and neck. One hour. Dr. SCHULTE.

55-56—Demonstrations—Osteology, syndesmology, myology, peripheral nervous system, and angiology of the extremities. Two hours. Drs. DARRACH and VAN BEUREN.

These courses are so arranged as to maintain, with reference to the subjects treated, a direct connection with the laboratory course in dissection, No. 57-58.

57-58—Laboratory Course—Dissection of the Human Body. Eighteen to twenty hours a week, at various hours, for from three to five periods of four weeks each. Professor HUNTINGTON, Professor GALLAUDET, and the DEMONSTRATORS OF ANATOMY.

59-60—Laboratory Course—Dissection of the Human Body. Ten to twelve hours a week for from six to eleven weeks. Professor HUNTINGTON, Professor GALLAUDET, and the DEMONSTRATORS OF ANATOMY.

61-62—Demonstrations—Anatomy of the mouth, pharynx, and

larynx— The auditory apparatus—The central nervous system. Three hours. Professor GALLAUDET.

63-64 — Demonstrations — Visceral anatomy. This course preserves an organic connection with Course 51-52, and presents for direct examination and demonstration the preparations serving to illustrate that course. Two hours. Dr. DARRACH.

65—Demonstrations—Anatomy of the cranial nerves. One hour for one-half year. Dr. SCHULTE.

66 — Mammalian Morphology — Introductory to the course in Physiology. Two hours for first half of the year. Professor HUNTINGTON and Dr. VAN BEUREN.

For courses in Comparative Anatomy, vertebrate and invertebrate, see also Department of Zoölogy, Courses Zoölogy 1-2, 101-102, and 201-202.

Graduate Courses

Course 117-118 may be offered as a major or minor for the degree of A.M. or Ph.D. according to special arrangement with the head of the department. It is optional for qualified candidates for the degree of M.D.

Courses 119-120 to 141-142 may be offered each as a minor for the degree of A.M. They are optional for candidates for the degree of M.D., and are open to post-graduate students in medicine. Minimum number of hours required, six per week from October 15th to April 1st.

Course 143-144 cannot be counted for a degree. It is open to teachers and qualified graduate students.

No courses in the Department of Anatomy are open to women.

117-118—The Laboratory of Animal Morphology is open for research, under the direction of the professor, to advanced workers. Professor HUNTINGTON.

119-148—Human and Comparative Anatomy, Special Courses—These subjects are optional for candidates for the degree of M.D., and are open to post-graduate students in medicine. They may be offered each as a minor for the degree of A.M.

149-150—Methods of Vital Statistics—1 hour. Optional. Professor BOAS.

In all courses offered in morphology the work is designed to be laboratory exercises of at least two continuous hours' duration at any one exercise, supplemented in certain courses by demonstration and study

of material contained in the Museum of Human and Comparative Anatomy and in the study collections of the department.

The time required for the above courses if offered as minors for the degree of A.M. is half a day per week from October to April.

The courses are given on Tuesday afternoons at the Anatomical Laboratory, College of Physicians and Surgeons, by Professor HUNTINGTON and Dr. DARRACH.

By special arrangement other hours are assigned to work in the cases of advanced students and investigators.

The demands on laboratory space and teaching force rendered it necessary to limit the number of candidates admitted to these courses.

BACTERIOLOGY

Preliminary Statement

Candidates for A.M. and Ph.D. taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical elementary chemistry. No preliminary work in bacteriology.

There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoölogy in the Department of Zoölogy.

None of the courses in this department is open to women, nor to Seniors in Columbia College.

51—Elementary Bacteriology, especially adapted to the requirements of students of medicine, four hours a week for one half of the academic year; given in the Department of Bacteriology under the Medical Faculty. Professor HISS and Drs. WADSWORTH, ZINSSER, and ALLEN.

Graduate Courses

201—Special Laboratory Course in Advanced Bacteriology—This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study and measurement of bacteria; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of

cultural characters, biochemical reactions, and identification of species; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides; biological examinations of water, soil, air, foods, and industrial products.

During the last weeks of the course an opportunity is afforded to the student to elect some special division of the subject, sanitary, medical, or industrial, to which he will devote his time.

Text-books: Eyre's *Bacteriological Technique*, Kolle u. Wassermann's *Handbuch d. Pathogenen Mikroorganismen*, Macé's *Bactériologie*.

The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon in November, December, and January. Professor HISS and Drs. WADSWORTH and ZINSSER.

Minor for one year for the degree of A.M. or Ph.D.

203—Advanced Bacteriology with Research—As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; practical work in photomicrography, and the pursuit of some selected theme for original investigation. Professor HISS and Drs. LEAMING and WADSWORTH.

Text-book: Kolle and Wassermann's *Handbuch der pathogenen Mikroorganismen*.

Attendance and hours as in Course 201, with additional time for research.

Major for one year for the degree of A.M. or Ph.D.

Photography and Photomicrography

Practical instruction is given to a limited number of men in the photographic laboratories of the college, in the technique of photography and photomicrography. The time necessary for the acquirement of this technique varies with the facility of the student and the hours devoted to the theme, and is subject to special arrangement. Given in the Department of Pathology under the Medical Faculty.

The facilities in these laboratories may be drawn upon for purposes of record and illustration by instructors and investigators in various departments of the University. Dr. LEAMING.

Research

Research in bacteriology may be pursued in the laboratories of this department by a limited number of graduate students or practitioners of medicine or other advanced workers, under the direction of the professor. To such men the large collection of bacterial cultures belonging to this department are accessible. Professor HISS.

BIOLOGICAL CHEMISTRY

(Including Physical and Organic Chemistry, Physiological and Pathological Chemistry, Toxicological Chemistry, and Botanical Chemistry.)

51—Physical and Organic Chemistry—The course treats of the fundamental facts and theories of physical and organic chemistry.

Most of the time of the course is devoted to a study of the aliphatic derivatives. The constitution and relationships of leading groups of carbocyclic and heterocyclic compounds are also reviewed. Typical substances are made synthetically and the properties of substitution and addition products are ascertained experimentally. Fats, carbohydrates, and proteins are studied in considerable detail.

Throughout the course due consideration is given to the leading facts of physical chemistry, especially to the laws and theories relating to mass action, heat and chemical change, catalysis, osmosis, electrolytic dissociation and similar subjects of special significance for the student of medicine.

Course 51 is required in the first half of the first year for candidates for M.D., and is open as an elective to qualified Seniors of Columbia College.

The lectures and laboratory work are illustrated by numerous demonstrations. (First half-year.)

Lectures (the entire class, 2 per week). 1 hour. Recitations (each section [2] two per week). 1 hour. Laboratory exercises (each section [2] two per week). 3 hours. Professor GIES, Drs. MEYER and BERG.

102—General Physiological Chemistry—The course embraces a study of the chemical changes normally occurring in organisms, also of the constituents (and of the functions and uses of the constituents) of the tissues, secretions, etc. Among the various subjects considered experimentally are the tissues and organs, food, digestion, milk, urine, etc.

The recitations are so conducted as to review and more fully explain the results of the laboratory work and demonstrations. The lectures, however, are devoted mainly to such topics of a general nature as cannot well be brought up in the laboratory for direct experimentation or demonstration in the time allowed for the course.

Among the themes considered in the lectures are such as the physico-chemical nature of protoplasm and the contents of the cell, chemical reactions in the cells, respiration, metabolism, internal secretion, the chemical influences of micro-organisms in the body, chemical defences of the organism, etc.

In this treatment of chemical physiology the attention of the

student is also directed from time to time to various related facts of a chemico-pathological character.

Course 102 is required in the second half of the first year, for candidates for M.D., in continuation of the course of physical and organic chemistry. The course is open as an elective to qualified Seniors of Columbia College.

The lectures and the laboratory exercises are illustrated by numerous demonstrations. (Second half-year.)

Lecture (the entire class, weekly). 1 hour. Recitation (each section [2] two weekly). 1 hour. Laboratory exercises (each section [2] two per week). 3 hours. Professor GIES, Drs. FOSTER, MEYER, and BERG and Mr. WELKER.

103—**Elementary Physiological Chemistry, etc.**, as given, page 137, University Catalogue.

201-202—**Laboratory Course in Quantitative Physiological Chemistry**—Numerous clinical methods are studied in detail. 6 hours. Professor GIES and Mr. BERG.

203-204—**Laboratory Course in Advanced Physiological and Pathological Chemistry**—This course is arranged for students who wish to make a very thorough study of bio-chemical science. It particularly affords opportunity for experimental observations of the more intricate phases of chemical physiology and pathology, and terminates in original investigation under personal direction. 12 hours. Professor GIES and Dr. FOSTER.

205-206—**Laboratory Course in Toxicological Chemistry**—A study of methods for the detection and quantitative determination of alkaloids and other poisons. 6 hours. Professor GIES and Mr. WELKER.

207-208—**Laboratory Course in the Chemical Physiology of Plants**—A study of the chemistry of substances found in plants.

The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is consulting chemist. 6 hours. Professor GIES.

In addition to the courses referred to above Professor GIES co-operates with Professor BURTON-OPITZ in giving Course 101-102 in Physiology.

301-302—**Bio-chemical Seminar**—The members of the teaching staff and all other investigators in the department meet weekly to study and discuss recent researches in chemical biology. The seminar is open to all students in the University. 2 hours. Professor GIES in charge.

Research—The laboratory is open to advanced workers for research carried on independently or under guidance. Professor GIES consults regularly with investigators in the Department of Zoology on Monday afternoons and at the New York Botanical Garden on Friday afternoons.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of the principles of general biology, and the subject-matter of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. Major work in the subject presupposes the ability to commence a definite line of research under the direction of an instructor. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued as a three-hour subject for three years. By reference to the statement of courses, given below, the equivalent expected can be seen. For example, Courses 1-2, 3-4, and 101-102 for men or Courses 51-52, 53-54, 153, and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. The amount of time required for the completion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through, which cannot possibly take less than two years (including work during two summers) for Ph.D. or one year for A.M.

Minor work in botany presupposes two years' preparation in the subject, with at least two full courses for Ph.D. or one full course for A.M.

All major courses and most minor courses are conducted at the Museum building of the New York Botanical Garden, under the direction of members of the botanical staff of the University and of the Garden staff.

All graduate courses are open to women.

Courses in Columbia College

1-2—Nature and development of plant life. C 2, and L 4 hours. Dr. CURTIS and Mr. DARLING.

3—Morphology of higher plants—Involving field work on adaptation of structure to physical conditions. C 2, and L 4 hours. Dr. CURTIS.

4—Morphology of some group or groups of the lower plants. L 6 hours. This course naturally follows Course 3, to complete an elective for the year. Mr. DARLING.

5—Problems in botanical technique. L 6 hours. Dr. CURTIS.

6—Economic botany—Study of plants useful to man. C 1, L 3 hours. Professor UNDERWOOD.

7—Lectures on general botany—A brief review of the characters and relations of plants, with special attention to the study of timber trees and their identification. 1 lecture, assigned reading, field and laboratory work. Professor UNDERWOOD and Mr. DARLING.

101-102—Plant physiology—A course in experimental physiology supplemented by selected readings and conferences. 2 laboratory sessions. Dr. CURTIS.

Courses in Barnard College

51-52—Principles of plant morphology and physiology. 5 hours, lectures, demonstrations, and laboratory work. Professor RICHARDS, Miss LATHAM and Miss THOMPSON

53-54—General morphology and development of plants. C 2, L 4 or 6 hours. Dr. HAZEN and Miss THOMPSON.

55-56—Morphology and classification of spermatophytes—With practice in determination of species. C 1, L 4 or 6 hours. Dr. HAZEN.
[151-152—Bacteria and the lower fungi. C 1, L 6 hours.]

153—Anatomy of vascular plants. C 2 and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM.

154—Physiology of plants from standpoint of nutrition. C 2 and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM.

[156—Physiology of plants from standpoint of growth. C 2 and a minimum of L 6 hours. Professor RICHARDS.]

Courses 154 and 156 are given in alternate second half-years.

155—Structure and development of algæ—Advanced course. C 1, L 6 hours. Professor RICHARDS and Dr. HAZEN.

159—Structure and development of fungi—Advanced course. Professor RICHARDS. C 1, L 6 hours.

Courses 158 and 159 are not usually given the same year.

160—Developmental anatomy—Practice in methods of technique. Professor RICHARDS. 8 hours of laboratory work with occasional lectures and outside reading.

161-162—Advanced physiology and morphology. Professor RICHARDS and Dr. HAZEN. Work will be arranged to suit the needs of the students.

Graduate Courses at New York Botanical Garden

201-202—General physiology—Problems in absorption, excretion, nutrition, and transformation of energy, growth, the general irritable organization of the plant, and the mechanism of its movements. Professor RICHARDS and Dr. CURTIS.

203-204—Physiological anatomy—Problems in the relationships of tissues and functions. Dr. CURTIS.

205-206—Physiology of the cell—Problems in the chemical and physical properties, movements, and irritability of unicellular and other generalized organisms. Professor RICHARDS.

207-208—Physiology of nutrition—Treated from a chemical standpoint. Professor RICHARDS and Professor GIES.

209-210—Ecological physiology—Problems in adaptive reactions

in form, structure, and movements to external energy and environmental factors. Drs. GAGER and CURTIS.

211-212—General plant pathology. Also problems in immunity and effects of unfavorable environment. Two summers in the field. Dr. MURRILL.

213-214—Morphology of spermatophyta—Study of the structure and development of the seed plants. Professor RICHARDS and Dr. CURTIS.

215-216—Experimental morphology—A study of the variation of form and structure, and the determination of the causes. Drs. CURTIS and GAGER

217-218—Embryology of spermatophyta. With special work during two summers. Dr. CURTIS.

219-220—Morphology of pteridophyta—Study of the structure and development of the ferns and fern-allies. Professor UNDERWOOD.

221-222—Morphology of bryophyta, with special reference to the diagnostic characters and relationships of the principal families and genera. Professor UNDERWOOD, Dr. HOWE, and Mrs. BRITTON.

223-224—Morphology of algæ, with special reference to the diagnostic characters and relationships of the principal families and genera. Dr. HOWE and Dr. HAZEN.

225-226—Morphology of fungi—Study of the structure, polymorphism and development of the fungi, including culture methods. Dr. MURRILL and Professor UNDERWOOD.

227-228—Taxonomy of spermatophyta—Study of the principal families. Professor BRITTON, Drs. SMALL and RYDBERG.

229-230—Taxonomy of gramineæ—Study of the diagnostic characters and relationships of the principal genera. Mr. NASH.

231-232—Taxonomy of pteridophyta—Study of the diagnostic characters and relationships of the principal families and genera. Professor UNDERWOOD.

233-234—Special taxonomy—Critical study of a family or genus of plants of not less than fifty species. The group may be chosen from the entire range of the vegetable world. Field, herbarium, laboratory, and garden work. Directed, according to the group chosen, by Professor UNDERWOOD, Professor BRITTON, Dr. HOWE, Dr. SMALL, Dr. RYDBERG, Mr. NASH, Professor BURGESS, and Mrs. BRITTON.

235-236—Regional botany—Collection, determination, and comparative study of the plants of some restricted area. Professors UNDERWOOD and BRITTON.

Prerequisite: three years' work in botany.

237-238—Plant geography—Occurrence, characters, and arrangement of groups and formations. Relations of plant societies to one another, and to topographic, climatic, and other conditions. Factors governing distribution. Professor BRITTON and Dr. CURTIS.

239-240—Developmental taxonomy—Fossil ancestors of some family of plants. Dr. HOLLICK.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor BIGELOW and Miss BROADHURST. See **Education 153-154, 183-184, 253-254** in Teachers College Announcement. The same instructors also offer three elementary subject-matter courses in biology; see **Biology 53-54 and 58, and Nature-Study 1-2** in Teachers College Announcement.

PHYSIOLOGY

College of Physicians and Surgeons

Candidates for the degree of M.D. are required to take Course **108-109**.

Courses **103-104, 105-106, 107, 108-109, 111-112** are not open to women nor to students of Columbia College, except in so far as Course **108-109** is required of Seniors who are taking their first year in medicine.

Candidates for the degree of A.M. may take (a) Courses **103-104 and 105-106**, or (b) in the first half-year, either Courses **109 and 107**, or Course **107** with a sufficient amount of prescribed reading, and, in the second half-year, a course in Biological Chemistry.

Candidates for the degree of Ph.D. are expected to take during their first year Courses **103-104 and 105-106**; during the first half of their second year, Course **107**, with Course **109** or with a sufficient amount of prescribed reading; and during the second half of their second year a course in Biological Chemistry.

103-104—General Physiology—Structure of protoplasm; physiology of the cell; physiological division of labor and physiological integration; chemistry of protoplasm; theory of solutions; osmosis; colloids; physical chemistry of the cell; irritability; contractility; the tropisms; secretion; structure and general functions of nerve-tissues; adaptation; Ehrlich's side-chain theory; antibodies. Lectures, 1 hour. Professor LEE.

105-106—Laboratory Course in General Physiology. 5 hours, Professor BURTON-OPITZ.

Open, in conjunction with Course **103-104**, to qualified candidates for the degree of A.M., M.D., or Ph.D.

108-109—The Physiology of Man as Related to that of other Mammals and of Lower Vertebrates—Lectures and demonstrations, 4 hours. Recitations, 1 hour; text-book, Howell's *Physiology*. Laboratory work, 3 hours. Professors CURTIS and BURTON-OPITZ, and Drs. EMERSON, SHEARER, BINGHAM, KEATOR, and YOCUM.

Open to qualified candidates for the degree of A.M. or Ph.D.

107—Laboratory Course in Special Physiology—3 hours during the first half-year. Professor CURTIS or Professor BURTON-OPITZ.

111-112—Electro-Physiology—Hours and work to be arranged with the Instructor. Dr. CUNNINGHAM.

Research—The laboratories are open for research, under the direction of their officers, to advanced workers.

Columbia College

101-102—Elementary Physiology—Given with the coöperation of the Department of Biological Chemistry. C 1, L 2 hours. 516 S. Professor BURTON-OPITZ.

Department of Botany

The following courses deal with **Plant Physiology** and are given detailed reference under the Department of Botany, pp. 18-21. They include Courses Nos. **101** and **102**, General Plant Physiology (Dr. C. C. CURTIS); **201-202**, Advanced Physiology (Professor RICHARDS and Dr. C. C. CURTIS); **205-206**, Plant Cell (Professor RICHARDS); **207-208**, Plant Nutrition (Professors GIES and RICHARDS); **209-210**, Ecological Physiology (Dr. C. C. CURTIS and Dr. GAGER), and **203-204**, Physiological Anatomy (Dr. C. C. CURTIS).

Barnard College

A course in general **Animal Physiology** is given by the Department of Zoölogy of Barnard College, supplementing the work in general Biology and Zoölogy. (See p. 26.) Miss REED.

Three courses in **Plant Physiology** are given by the Department of Botany of Barnard College (see p. 19): One dealing with Plant Nutrition, **Botany 154**, a second with Growth, **Botany 156**, a third with advanced problems in physiology, **Botany 161-162**. All given by Professor RICHARDS.

COURSES IN ZOOLOGY

Graduate major work in zoölogy requires at least two years of preparatory undergraduate study, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses **1-2** and **91-92**, to which may with advantage be added **93**, **4**, **5**, and **97-98**. For minor or special graduate work a less extensive preparation may suffice, but all candidates for the higher

degrees must have taken at least one year's work in zoölogy or elementary biology. Of the following courses, 1-2, 4, 5, 91-92, 93 and 97-98 are for undergraduates only.

In general less stress is laid on the completion of formal course-work for the higher degrees than on the attainment of an appropriate standard of knowledge and training, of which the best evidence is given by the master's thesis or the doctor's dissertation. The following examples of the course-work are not given as fixed requirements, but in order to illustrate some of the combinations of courses that may be taken.

Towards an A.M. major, students may take the equivalent of two one-day courses for one year; examples, 201 and 202 (two-day half-year courses), 204, 215 and 221-222 (one-day year courses) with any two of 106, 203, 205, 206, 209, 212, 213, 214, 216, 217 (one-day half-year courses). An A.M. minor represents approximately one-half a major. Students who have not taken 91-92 as undergraduates may take 101-102 as the equivalent of an A.M. minor.

The Ph.D. minor represents approximately the amount of work required for an A.M. major, though in either case specially assigned study or research (to be registered as Course 207) may take the place of formal course-work. For the Ph.D. major no fixed rule can be laid down, but in general the regular work may be roughly estimated as at least twice that required for a minor. Courses 201 and 202 are recommended to all Ph.D. major students as a general foundation. For a minor, Course 101-102 (or an equivalent) may constitute one-half the requirement in the case of students who have not taken 91-92 as undergraduates; for the remaining half any one of the full-year courses or any two of the half-year courses (as indicated above) may be taken. Students who have taken Course 91-92 as undergraduates may take in addition the equivalent of an A.M. major as specified above.

All of the graduate courses are open to women.

Courses in Columbia College

1-2—Elementary Biology (zoölogy)—Introductory to the general principles of biology and to animal morphology and physiology. This course is designed for students taking a year of science as part of a general course or in preparation for the study of medicine; it also forms a foundation-course for all the other courses in the department.

This work is arranged in a longer and shorter course, consisting of three and two exercises a week respectively. The shorter course omits the work in histology and embryology. In this course a detailed study of a series of living forms is made the basis for brief discussions of essential principles.

First Half-year

1(a)—General Biology—Two exercises a week throughout the first quarter-year. General introduction. Protoplasm and the cell.

General biology of the animal and plant. Unicellular organisms; Amœba, Pleurococcus, yeast, bacteria, infusoria. Professor CALKINS. 619 S.

1(b)—Elementary Zoölogy (invertebrates)—The comparative study of a series of types illustrating the outlines of invertebrate zoölogy. Two exercises throughout the second quarter-year. Professors CALKINS and MCGREGOR. 619 S.

1(c)—Elementary Histology (longer course)—General study of animal cells and tissues. One exercise a week throughout the half-year. Professor MCGREGOR. 619 S.

Second Half-year

2(a) Elementary Zoölogy (vertebrates)—The comparative study of a series of vertebrate types with brief discussions of the main problems of evolution and heredity. Two exercises a week. Professor DEAN. 619 S.

2(b) Elementary Embryology (longer course)—One exercise a week. Development of the frog and chick. Professor MORGAN. 619 S.

Text-books: Sedgwick and Wilson's *General Biology*, Marshall and Hurst's *Practical Zoölogy*. Reference books: Parker's *Elementary Biology*, Jordan and Kellogg's *Animal Life*, Osborn's *Greeks to Darwin*, and Marshall's *Vertebrate Embryology*.

Open to all undergraduates who have had entrance chemistry and physics or Science A. C 2 or 3, L 4 or 6 hours.

4—Experimental Biology—An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. This course gives opportunity to undergraduates to become familiar with some of the methods and results of experimental research in zoölogy, and forms a desirable preparation for Course 215. One afternoon. Professor MORGAN.

Open only to students who are taking at least one other laboratory course.

5—General Biology—Lectures, conferences, and laboratory work on the general principles of biology: variation, inheritance, evolution, geographical distribution, animal coloration and related topics.

This course supplements the general discussions given in Course 1-2 and 91-92 and gives opportunity for a more critical and extended treatment of general principles. One afternoon. Under the direction of Professor WILSON.

Open under the same condition as 4.

91-92—General Zoölogy—Vertebrate and invertebrate zoölogy, including anatomy, embryology, and etiology (natural environment, terrestrial and marine faunal areas, principles of distribution). This course directly continues the work of Course 1-2, and is designed to give a broad, general acquaintance with the principles of zoölogy and comparative morphology. It is recommended to students looking for-

ward to teaching and research, to prospective medical students, and to others whose courses are mainly in the natural sciences.

91—Comparative morphology, classification, and general zoölogy of invertebrates. Text-book: Parker and Haswell, *Zoölogy*, Vol. I. C 3, L 6 hours. Professor MCGREGOR. 619 S.

92—Classification and comparative anatomy of the main living orders of fishes, amphibians, reptiles, birds, and mammals. Practical study of the skeleton, integument, muscles, nerves, viscera. Text-book: Parker and Haswell, *Zoölogy*, Vol. II. C 3, L 6 hours. Professor MCGREGOR. 619 S.

93—Embryology of Vertebrates—An examination of the characteristic stages of fishes, amphibians, reptiles, birds and mammals. Embryological technique. Text-book: Mark's, Hertwig's *Vertebrate Embryology*. C 1, L 2 hours. Professor MCGREGOR. 619 S.

97-98—Practical Histology—Practical comparative study of tissues and organs, with especial reference to histological technique. This course forms a supplement to 91-92, but may be taken separately, or with 93. It is intended as partial preparation for subsequent work in medicine or biology. C 1, L 2 hours.

101-102—General Zoölogy—This course covers the same general ground as 91-92, but is supplemented by additional assigned work. It may not be counted as part of the major work towards the higher degrees. Professor MCGREGOR. Three lectures, six hours laboratory throughout the year.

106—Cellular Biology—General structure and functions of the cell. Six hours (one day) a week through the second half-year. Reference books: Wilson, *The Cell*; Hertwig, *The Cell*; Henneguy, *Leçons sur la Cellule*. Professor WILSON.

Open to graduates and to undergraduates who have at least two years of study in Zoölogy.

110—Special Morphology—The parasitic Protozoa. A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Six hours (one day) throughout the second half-year. Professor CALKINS.

Courses in Barnard College

1 (a)-2 (a)—General Biology and General Zoölogy—Elementary course. Professor CRAMPTON, Dr. OSBURN, Miss DEDERER, and Miss REED. C 2, L 4 hours.

1(b)—Histology—C 1, L 2 hours. First half-year.

2(b)—Embryology—C 1, L 2 hours. Second half-year.

4—Experimental Biology—An introduction to the experimental study of growth, reactions to stimuli, development, inheritance and related topics. Professor CRAMPTON. 3 hours C and L.

5—General Biology—The general principles of biology: variation,

inheritance, evolution, geographical distribution, animal coloration, and related topics. Professor CRAMPTON. 3 hours *C* and *L*.

101-102—General Zoölogy—Advanced course. Professor CRAMPTON, Dr. OSBURN, and Miss REED. *C* 3, *L* 6 hours.

151-152—General Physiology—General principles of animal physiology. Miss REED. *C* 2, *L* 4 hours.

153-154—Practical Zoölogy and Embryology—Miss DEDERER. 3 hours *C* and *L*.

Graduate Courses

A. Comparative Zoölogy

The two following courses are designed to complete the work in general zoölogy begun in 1-2 and continued in 91-92, and are recommended to all students making zoölogy their major subject. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work. Two days a week.

201—Topics in invertebrate zoölogy, with especial reference to problems of phylogeny. First half-year. Professor WILSON.

202—Evolution of the vertebrates, especially phylogenetic relations, adaptations, and broader classification of the principal groups—Designed for students of zoölogy, paleontology, and geology. The paleontological collections of the American Museum are used to illustrate this course. Second half-year. Professors OSBORN and MCGREGOR.

B. Embryology and Cellular Biology

208-209 — Comparative Embryology (see also 2 (b) and 93)—Facts and principles of animal development, etc.

208—Embryology (with special reference to comparative organogeny) **of the main Vertebrate Types**—Demonstrations and reading. One day a week during the first half-year. Professor DEAN.

209—General Embryology of Invertebrate Types—Special reading and laboratory work. One day a week during the second half-year. Professor CALKINS.

220—Cellular Embryology (see also 106 and 218)—A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. One lecture a week with reading, conferences, and specially arranged laboratory work through the second half-year. Courses 103 and 208 form a desirable preparation. This and 217 are parallel courses which supplement each other. Professor WILSON.

C. Morphology and Evolution of Special Groups

203-204—Mammals, Living and Fossil—Lecture and laboratory course. A study of the principles of the evolutionary history and adaptation, of the morphology and classification of living and fossil mammals. One or two lectures (one or more days) a week throughout the year. Professor OSBORN and Mr. GREGORY. The course is largely given in the American Museum of Natural History. Reference books: Weber's *Die Säugetiere*, Flower and Lydekker's *Mammals*.

205—Fishes, Living and Fossil—This course considers especially the phylogenetic relations of the sub-classes and orders of fishes. Reference books: Smith Woodward, *Catalogue of Fossil Fishes*; Günther, *Study of Fishes*; and Dean, *Fishes, Living and Fossil*. C 1, L 2 hours. Professor DEAN.

226—The Enterocœla (exclusive of the Protochordates)—A detailed study of the morphology and embryology of the Prosopygia and Echinodermata, as the basis for a critical examination of the phylogenetic relationships of these groups to other invertebrate as well as to the protochordate divisions. C 1, L 5 hours. This course and the following form a supplement to Course 201-202. Reference books: Lang, *Text-book of Comparative Anatomy*; Delage, *Zoologie Concrète*; Korschelt and Heider, *Text-book of Embryology*, together with special monographs. Professor CRAMPTON.

210—The Protochordates—A study of the morphology and embryology of the protochordate groups and allied forms, with special reference to their phylogenetic relationships and to the problems of vertebrate descent. One lecture and two hours laboratory during the second half-year. Reference books: Willey, *Amphioxus and the Ancestry of the Vertebrates*; Delage and Hérouard, *Zoologie Concrète*, Tome 8, *Les Procordés*, and special monographs and papers. Professor MCGREGOR.

D. Protozoölogy

The courses offered in this division are designed to give a basis for research on unicellular animals. Particular attention is given to the life history, to the bearing of Protozoa upon human disease, and to methods of research in this group of organisms.

221-222—Protozoölogy—A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology, and physiology. Six hours (one day) a week throughout the year. Professor CALKINS.

224—Microscopy of Drinking-waters—A general study of Protozoa and other microscopic forms in relation to water supplies. Biological examination of potable waters. Selected reading and laboratory work in the second half-year. Professor. CALKINS.

See also 110—**Parasitic Protozoa**.

E. Biology and Experimental Zoölogy

207—Advanced Biology—Individual study of special groups of animals or of special biological problems as an introduction to original investigation. The time varies in different cases.

212—The Experimental Study of Evolution—With special reference to the statistical study of variation and inheritance. One lecture a week, with readings and conferences in the second half-year. Professor CRAMPTON.

213—The Tropisms of Animals—The different types of responses of animals to stimuli, considered as adaptations and with especial reference to animal instincts. The origin of these responses is considered in connection with the question of continuous or discontinuous variation. One lecture, with demonstrations and opportunities for laboratory work, during the first half-year. Professor MORGAN.

215-216—Experimental Zoölogy—A study of those responses of animals that lead to changes of form, as contrasted with temporary physiological responses. This course includes a treatment of such questions as the influence of external conditions in modifying species and in affecting modes of reproduction, the influence of hybridization, the rate of growth as affected by the environment, the determination of sex, and the like. One lecture a week throughout the year, with laboratory work on special problems. Professor MORGAN.

217—Regeneration—The phenomena of regeneration are studied as illustrating one of the modes of organic growth. A principal feature of this course is the formulation of special problems for further investigation. One lecture a week during the first half-year. Professor MORGAN.

218—Experimental Embryology—The influence of external factors on normal development, and the modification due to changed external conditions. This course is parallel to 203, which treats of the internal factors. One lecture a week during the second half-year. Professor MORGAN.

Course in the College of Physicians and Surgeons

51-52—Practical instruction in histology and embryology. 7½ hours. Professor BAILEY and Drs. STRONG, MILLER, BANKER, and SMITH.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor BIGELOW and Miss BROADHURST. See **Education 153-154, 183-184, 253-254** in Teachers College Announcement. The same instructors also offer three elementary subject-matter courses in biology; see **Biology 53-54** and **58**, and **Nature-Study 1-2** in Teachers College Announcement.



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Columbia University Bulletin of Information

UNIVERSITY OF ILLINOIS

PRESIDENT'S OFFICE

DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PATHOLOGY,
PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1909-1911

Published by
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Columbia University

Bulletin of Information

(Issued 25 times during the Academic year, monthly in November and December, and weekly between February and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under Act of July 16, 1894.)

These include :

1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, issued in December, price 25 cents.
3. The Announcements of the several Colleges, and Schools and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University. For information as to the various courses offered by the University consult the last page of this Announcement.

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ABRIDGED ACADEMIC CALENDAR

The Academic year is thirty-seven weeks in length, ending on the Wednesday nearest the 11th of June. In 1909-10 the year begins on September 22, 1909, and ends on June 8, 1910. It is divided into two half-years of fifteen weeks of instruction each. In 1909-10 the second half-year begins on February 3, 1910. The Summer Session for 1909 begins on July 7 and ends on August 18.

The exercises of the University are suspended on Election Day, Thanksgiving Day, and the following two days, for two weeks at Christmas, on Washington's Birthday, from the Thursday before Good Friday through the following Monday, and on Memorial Day.

The complete Academic Calendar will be found in the University catalogue and so far as it refers to the students studying under any Faculty, in the announcement of that Faculty.

OFFICERS OF THE DIVISION OF BIOLOGY

- GEORGE S. HUNTINGTON.....*Professor of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D.,
Jefferson Medical College, 1907.
- HENRY FAIRFIELD OSBORN.....*Da Costa Professor of Zoölogy*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity College (Hartford), 1901;
Princeton, 1902; Columbia, 1907; Sc.D., Cambridge, 1904.
- EDMUND B. WILSON.....*Professor of Zoölogy*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902;
LL.D., Chicago, 1901.
- FREDERIC S. LEE.....*Professor of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN.....*Professor of Vertebrate Zoölogy*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D.,
1890.
- HENRY E. CRAMPTON.....*Professor of Zoölogy*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES.....*Professor of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS.....*Professor of Botany and Secretary of
the Division*
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS.....*Professor of Protozoölogy*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.
- PHILIP HANSON HISS, Jr.....*Professor of Bacteriology*
A.B., Johns Hopkins, 1891; M.D., Columbia, 1895.
- MAURICE A. BIGELOW.....*Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- RUSSELL BURTON-OPITZ.....*Adjunct Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN.....*Professor of Experimental Zoölogy*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891.
- BERN B. GALLAUDET.....*Adjunct Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.
- JAMES HOWARD MCGREGOR.....*Adjunct Professor of Zoölogy*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- CARLTON CLARENCE CURTIS.....*Adjunct Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.
- HERMANN VON W. SCHULTE.....*Adjunct Professor of Anatomy*
A.B., Trinity, 1897; M.D., Columbia, 1902.
- WILLIAM G. MACCALLUM.....*Professor of Pathology*
A.B., Toronto, 1894; M.D., Johns Hopkins, 1897.
- AUGUSTUS B. WADSWORTH.....*Adjunct Professor of Bacteriology*
B.S., Massachusetts Institute of Technology, 1893; M.D., Columbia, 1896.

- NELLIS B. FOSTER.....*Associate in Biological Chemistry*
M.D., Johns Hopkins, 1902.
- WILLIAM DARRACH.....*Associate in Anatomy*
A.B., Yale, 1897; M.D. and A.M., Columbia, 1901.
- FREDERICK T. VAN BEUREN, Jr.....*Associate in Anatomy*
A.B., Yale, 1898; M.D., Columbia, 1902.
- EDWARD LEAMING.....*Instructor in Photography*
M.D., Columbia, 1892.
- TRACY E. HAZEN.....*Instructor in Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- RAYMOND C. OSBURN.....*Instructor in Zoölogy*
B.S., Ohio State, 1898; M.S., 1900; Ph.D., Columbia, 1906.
- HANS ZINSSER.....*Instructor in Bacteriology and Hygiene*
A.B., Columbia, 1899; A.M. and M.D., 1903.
- MATTHEW STEEL.....*Instructor in Biological Chemistry*
B.S., New Mexico College of Agriculture and Mechanic Arts, 1901; M.S., 1902.
- ARCHIBALD E. OLPP.....*Instructor in Biological Chemistry*
A.C., Lehigh, 1903; M.D., Pennsylvania, 1908.
- HAVEN EMERSON.....*Demonstrator of Physiology*
A.B., Harvard, 1896; M.D. and A.M., Columbia, 1899.
- LEANDER H. SHEARER.....*Demonstrator of Physiology*
A.B., Princeton, 1897; M.D., Columbia, 1901.
- ARTHUR W. BINGHAM.....*Demonstrator of Physiology*
A.B., Yale, 1896; M.D., Columbia, 1900.
- CHARLES R. L. PUTNAM.....*Demonstrator of Anatomy*
M.D., Harvard, 1895.
- HARRY M. KEATOR.....*Demonstrator of Physiology*
A.B., Yale, 1897; M.D., Columbia, 1902.
- PAULINE H. DEDERER.....*Tutor in Zoölogy in Barnard College*
A.B., Columbia, 1901; A.M., 1907.
- MARION E. LATHAM.....*Tutor in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- CHESTER A. DARLING.....*Tutor in Botany*
A.B., Albion, 1904; A.M., 1906.
- CAROLINE STACKPOLE.....*Tutor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- WILLIAM K. GREGORY.....*Lecturer in Zoölogy*
A.B., Columbia, 1900; A.M., 1905.
- ALFRED P. LOTHROP.....*Assistant in Biological Chemistry*
A.B., Oberlin, 1906; A.M., 1907.
- WALTER H. EDDY.....*Assistant in Biological Chemistry*
B.S., Amherst, 1898; A.M., Columbia, 1908.
- MARGARET A. KINGSLEY.....*Assistant in Botany in Barnard College*
A.B., Smith, 1908.
- HERMAN O. MOSENTHAL.....*Assistant in Biological Chemistry*
A.B., Columbia, 1899; M.D., 1903.
- HENRY J. SPENCER.....*Assistant in Zoölogy*
A.B., Syracuse, 1907; A.M., Williams, 1908.
- CHARLES S. MEAD.....*Assistant in Zoölogy*
B.S., Ohio State, 1904; A.M., Columbia, 1906.

**Members of the Staff of the Botanical Garden Giving Instruction
in the Division**

NATHANIEL LORD BRITTON, Ph.D., Sc.D.....	<i>Director</i>
WILLIAM ALPHONSO MURRILL, Ph.D.....	<i>Assistant Director</i>
FRED. JAY SEAVER, M.S.....	<i>Director of the Laboratories</i>
JOHN KUNKEL SMALL, Ph.D.....	<i>Head Curator of the Museums</i>
PER AXEL RYBERG, Ph.D.....	<i>Curator</i>
ARTHUR HOLLICK, Ph.D.....	<i>Curator</i>
MARSHALL AVERY HOWE, Ph.D.....	<i>Curator</i>
GEORGE VALENTINE NASH.....	<i>Curator of the Plantations</i>
HENRY HURD RUSBY, M.D.....	<i>Curator of Economic Collections</i>

Partial Courses are also Given by

ELIZABETH GERTRUDE BRITTON.
EDWARD SANFORD BURGESS, Ph.D.

GENERAL STATEMENT

INTRODUCTORY

The Division of Biology includes the departments of Anatomy, Bacteriology, Botany, Physiology, Biological Chemistry, and Zoölogy in all schools of the University. The present announcement is therefore designed to give under separate headings a list of all biological courses, whether in Columbia College, the School of Pure Science, the College of Physicians and Surgeons, Barnard College, or Teachers College.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those granted to men.

Students are received as candidates for the degrees of Master of Arts and Doctor of Philosophy under the Faculty of Pure Science; for the degrees of Bachelor of Arts and Bachelor of Science either in Columbia College or in Barnard College; and for the degree of Bachelor of Science in Teachers College. They are also permitted to pursue special or partial courses subject to the regulations of the Faculty under which they may register.

Certain courses which may be counted toward the several degrees are also offered in the Summer Session of the University.

The Degrees of M.A. and Ph.D.

Candidates for the degrees of Master of Arts and Doctor of Philosophy must hold a baccalaureate degree in arts, letters, philosophy, or science, or an engineering degree, or an equivalent of one of these from a foreign institution of learning. Every candidate for a higher degree must present to the Dean of the Faculty under which he intends to study satisfactory evidence that he is qualified for the studies he desires to undertake.

Candidates must pursue their studies in residence for a minimum period of one and two years, respectively. The complete regulations will be found in the *Announcement of the Faculties of Political Science, Philosophy, and Pure Science*, which may be had on application to the Secretary of the University. This Announcement contains also a detailed statement as to the election of major and minor subjects, and an estimate of the amount of time necessary for their completion. Attention is called to the material entitled *Instruction for Graduate Students Leading to the Degrees of Master of Arts and Doctor of Philosophy*, and particularly to the fact that the requirements for the higher degrees are based upon subjects and not upon courses. Students who wish to offer a subject, either as a major or minor, should, before registration, consult the officers of instruction concerned with regard to their selection of courses. Hours for consultation are appointed,

which may be learned by reference to the general catalogue or by application to the Secretary of the University.

In practice, three years of study are usually necessary to obtain the degree of Doctor of Philosophy.

The following special regulations of the Faculty of Pure Science should have the attention of students under that Faculty.

The student is expected to gain a sound general knowledge of the two minor subjects of his choice. In the major subject a much more thorough and special knowledge is required, particular importance being attached to training in research. In the School of Pure Science, however, two subjects can be chosen in the same department only by special vote of the Faculty. By this means undue specialization can be controlled.

The approval of the subject of the dissertation required for the degree of Master of Arts or of Doctor of Philosophy rests with the instructor in charge of the candidate's major subject. It is desirable that the studies upon which a dissertation is based should be related, and when practicable, that they should be treated respectively as preliminary and completed investigations. Great importance is attached to the character of the final dissertation. While it must depend for acceptance chiefly on the subject-matter, it should show good literary workmanship, especially by directness and clearness of statement. It should demonstrate the author's capacity to do original scientific work and to render an intelligible account thereof. It should evince a familiarity with the literature of the subject and with the latest methods of research. The treatment should be as concise as the nature of the work permits. Every dissertation should be preceded by a clear introductory statement, setting forth the nature and the scope of the research, and be followed by a summary of the results and the conclusions obtained. It should also be accompanied by a table of contents and by a list of the authorities consulted in its preparation.

Complete details as to the administrative regulations of the University and as to the privileges offered to its students will be found either in the University catalogue or in the *Announcements* of the several Faculties.

Fellowships and Scholarships

Columbia University expends nearly \$75,000 annually in assisting deserving students. There are twelve University Fellowships, of an annual value of \$650 each, and in addition three specially endowed fellowships open to advanced students in biological research; thirty-two University Scholarships, including four open to women, of an annual value of \$150 each; and numerous scholarships for undergraduates in Columbia College, Barnard College, and Teachers College. There is a special scholarship in biology amounting to \$200 awarded

annually by the Wawepex Society. This includes the use of a biological table at Cold Spring Harbor, Long Island.

The regulations governing the award of fellowships and scholarships will be found in the appropriate University bulletins to which reference has already been made, and the blank forms of application may be obtained from the Secretary of the University. Applications should be filed for fellowships not later than March 1; for scholarships, not later than May 1.

Funds and Prizes

Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open therefore to students of the Division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

The University maintains Committees on Employment for Students and on Appointment. Through the former, deserving and competent students are enabled to obtain work, either during the academic year or in the summer vacation, which will help them to defray their expenses while at the University; through the latter, assistance is offered to graduates to obtain suitable permanent positions. Communications should be addressed to the Committee in each case.

Residence Halls

There is a University Commons and Residence Halls with provision for 500 men. There are also Dormitories for women. A special pamphlet with regard to these halls may be had upon application.

ORGANIZATION AND EQUIPMENT

Anatomy

The laboratory for advanced morphological research occupies the third story of the Anatomical Building. Every facility for advanced and research work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology

The work in Bacteriology is conducted in a special section of the northern wing of the College of Physicians and Surgeons in the Depart-

ment of Pathology. The laboratories for the morphological and biological study of micro-organisms are suitably equipped, and the systematic study is greatly facilitated by the maintenance of the large collection of the known forms of bacteria under cultivation. The facilities for work in photomicrography, which are maintained in connection with the Department of Pathology, are accessible to workers in bacteriology.

Biological Chemistry

The headquarters of the Department of Biological Chemistry are situated at the College of Physicians, where there are six well-equipped rooms for experimental work. Two of these are relatively large and will each accommodate about seventy workers at a time. Four smaller rooms are specially fitted up for original investigations by advanced students.

At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry under the auspices of the University Department of Biological Chemistry. A small laboratory in Schermerhorn Hall has been equipped for research in biological chemistry to be carried out in coöperation with the Department of Zoölogy. Similar provision has been made in Fayerweather Hall for biochemical research in collaboration with workers in the Department of Physics. Special facilities have been provided at the New York Zoölogical Park for research there in biological chemistry under the direction of the head of this department. The laboratories of the New York Botanical Garden are open to students of biological chemistry.

Professor Gies's library occupies a room adjoining the laboratory at the medical school and is accessible by appointment to all students in the University.

Botany

The Department of Botany occupies the third floor of Schermerhorn, and the laboratories and lecture-rooms are thoroughly equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

By the agreement entered into between the University and the Garden, the herbarium and library of the University (except such works as are needed in the undergraduate courses) have been deposited in the Museum of the Botanical Garden at Bronx Park; the Garden on its part supplies all needed facilities for research for members of the staff and for properly accredited students. This combination of forces not only places the Department of Botany within reach of material, equipment and collections not otherwise available, but opens up facilities for research work under conditions that are not excelled.

The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. Ample opportunity for experimental work is afforded by the open-air plantations and extensive horticultural houses, and the aggregation of collections available for students is exceptionally full in every group of plants.

The library comprises over 20,000 volumes in addition to complete sets of the important botanical journals, which now number over one hundred.

Pathology

In the Pathological Laboratories of the College of Physicians and Surgeons on Fifty-ninth Street there are ample facilities for every sort of research work in Pathology. An abundant material to illustrate the anatomical lesions on disease is brought to the laboratory from various hospitals and is constantly available for study. Very complete arrangements for experimental work in pathology are being installed with all necessary apparatus, and it is especially in this important department of the work that investigations may be carried out with advantage.

The laboratories for practical instruction in general pathology are large and the library of the department is sufficiently complete to supply most of the wants of the students.

Physiology

At the College of Physicians and Surgeons there is a laboratory for research and the preparing of demonstrations, a small laboratory for histological research with special reference to physiological problems, and two rooms for optical or psychological work, or for photography. There are also two laboratories for practical instruction. In the Swift Physiological Cabinet, which is specially endowed, there is a very full collection of apparatus of precision, mainly for research.

In Schermerhorn Hall there is a laboratory equipped for the instruction of undergraduates.

The physiological journals are accessible to the students of the department; also the most important books, both modern and ancient.

A skilled mechanic is employed to devote his entire working time to the care and improvement of the plant, including the making, altering, and repairing of special apparatus. He also assists in the scientific manipulations.

Zoölogy

The zoölogical laboratories on the upper floor of Schermerhorn comprise a large general undergraduate laboratory, two graduate labora-

tories, a laboratory for experimental zoölogy, and eight rooms for private research, besides special rooms for supplies, aquaria, and preparation. There is also a commodious lecture-room, a library, and a seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the great collections of the American Museum of Natural History (see below) the department does not maintain a general zoölogical museum. The equipment includes, however, an extensive teaching collection of animals, anatomical preparations, charts and wax models and an aquarium room in which a variety of living animals and plants are kept.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, a part of the University library kept in the laboratory, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes the journals and a rapidly increasing collection of special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. Most of the current biological journals are subscribed for. The valuable libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains very extensive collections illustrating the zoölogy and palæontology of invertebrates and vertebrates, both from the systematic and bionomic point of view. The exhibition halls are always open to students, and certain of the University lectures and certain courses of research are conducted in the museum. Application should be made to Professor H. C. BUMPUS, Director.

The Zoölogical Park in the Borough of the Bronx, under the direction of the New York Zoölogical Society, affords exceptional opportunities for the study of living reptiles, birds, and mammals. The park is under the general direction of Director William T. Hornaday, to whom applications should be addressed. The birds are in charge of Mr. C. William Beebe, the reptiles and amphibians in charge of Mr. R. L. Ditmars. A biological laboratory is planned in connection with the hospital service of the park.

The New York Aquarium, also under the management of the Zoölogical Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a complete fish hatchery, which is in operation all the year round. Application should be made to Director Charles H. Townsend.

One of the special features of the department is the journal club, open to instructors and all advanced students, and meeting every week in the departmental library to report upon special investigations and

to present abstracts of articles of special importance in the biological journals.

A weekly seminar open to all members of the department is usually also carried on in the second half-year, for the more thorough discussion of some one selected topic of general interest.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former three investigators' rooms are subscribed for by the University for the use of the Department of Zoölogy; in the latter a table is available through the John D. Jones Scholarship. Circulars of the summer courses are obtainable in the department. The University also maintains an investigators' table at the Naples Zoölogical Station, for which application may be made to Professor E. B. Wilson. In addition to the above facilities field-expeditions are from time to time sent out by the department.

Publications by Members of the Division

The University Press issues the *Columbia University Biological Series*, a number of educational volumes originally founded upon public lectures, of which ten have already appeared and another is in press. Another feature in advanced instruction is the connection with the biological section of the New York Academy of Sciences, which affords opportunities for reading, discussing, and printing scientific papers.

Two series of publications are issued from the Department of Botany: a quarto series known as the *Memoirs of the Department of Botany*, of which two volumes have been published; and the *Contributions from the Department of Botany*, in octavo, which have commenced on the tenth volume.

There are issued yearly *Studies from the Department of Pathology*, of which nine volumes have been published.

The *Columbia University Quarterly* contains each year reports of the work of the several departments in this division.

DEPARTMENTAL STATEMENTS OF COURSES

Introductory

The courses of instruction are numbered in accordance with a plan uniform throughout the University, and attention is called to the following information which the number assigned to a course will in each case indicate:

Odd numbers indicate the first, even numbers the second half of the academic year. Courses designated 1-2, 21-22, etc., run through both half-years. Courses numbered between 1 and 100 are, in general, elementary and may not be offered in fulfilment of the requirements for the higher degrees (A.M. and Ph.D.). Courses numbered from

101-200 are primarily for students who hold a first degree, but are open to undergraduates who have completed 72 points (for courses in law 94 points), including all prescribed work. In general no such course may be taken without some elementary training in the same or in some allied subject. Courses from 201-300 are restricted to such graduate students as are qualified to pursue the work to advantage. Seminars are numbered from 301 up.

Courses enclosed in brackets are not offered during 1909-1910, and the instructor may withdraw any other course that is not applied for by at least three candidates for a degree.

Unless otherwise stated, the number of hours given indicates the hours of classroom work (lectures, conferences, and recitations) per week. When a course involves both classroom work and laboratory work the former will be indicated by *C* and the latter by *L* respectively. An "afternoon" implies three hours a day, normally from one to four.

ANATOMY

Courses 53-54, 55-56, 57, 58 and 66 are required in the first year of candidates for the degree of M.D. The four courses together may be elected by Seniors in Columbia College.

Courses 51-52, 59-60, 61-62, 63-64 and 65 are required in the second year of candidates for the degree of M.D.

Courses 117-118 and 149-150 are optional for qualified candidates for the degree of M.D. May be offered as a major or minor for the degree of A.M. or Ph.D. according to special arrangement with the head of the department.

51-52—Vertebrate Morphology—Anatomy of the body cavities—Visceral and topographical course—Thorax and abdomen. Lectures combined with demonstrations. Three hours. Professor HUNTINGTON.

53-54—Demonstrations—Cranial osteology, syndesmology, myology, peripheral nervous system, and angiology of the head and neck. One hour. Professor SCHULTE.

55-56—Demonstrations—Osteology, syndesmology, myology, peripheral nervous system, and angiology of the extremities. Two hours. Drs. DARRACH and VAN BEUREN.

These courses are so arranged as to maintain, with reference to the subjects treated, a direct connection with the laboratory course in dissection, No. 57-58.

57-58—Laboratory Course—Dissection of the Human Body. Eighteen to twenty hours a week, at various hours, for from three to five periods of four weeks each. Professor HUNTINGTON, Professor GALLAUDET, and the DEMONSTRATORS OF ANATOMY.

59-60—Laboratory Course—Dissection of the Human Body. Ten to twelve hours a week for from six to eleven weeks. Professor

HUNTINGTON, Professor GALLAUDET, and the DEMONSTRATORS OF ANATOMY.

61-62—Demonstrations—Anatomy of the mouth, pharynx, and larynx—The auditory apparatus—The central nervous system. Three hours. Professor GALLAUDET.

63-64—Demonstrations—Visceral Anatomy. This course preserves an organic connection with Course 51-52, and presents for direct examination and demonstration the preparations serving to illustrate that course. Two hours. Dr. DARRACH.

65—Demonstrations—Anatomy of the Cranial Nerves. One hour for one-half year. Dr. SCHULTE.

66—Mammalian Morphology—Introductory to the course in Physiology. Two hours for first half of the year. Professor HUNTINGTON and Dr. VAN BEUREN.

For courses in Comparative Anatomy, vertebrate and invertebrate, see also Department of Zoölogy, Courses Zoölogy 1-2, 101-102, and 201-202.

Graduate Courses

Course 117-118 may be offered as a major or minor for the degree of A.M. or Ph.D. according to special arrangement with the head of the department. It is optional for qualified candidates for the degree of M.D.

Courses 119-120 to 141-142 may be offered each as a minor for the degree of A.M. They are optional for candidates for the degree of M.D., and are open to post-graduate students in medicine. Minimum number of hours required, six per week from October 15th to April 1st.

Course 143-144 cannot be counted for a degree. It is open to teachers and qualified graduate students.

No courses in the Department of Anatomy are open to women.

117-118—The Laboratory of Animal Morphology is open for research, under the direction of the professor, to advanced workers. Professor HUNTINGTON.

119-148—Human and Comparative Anatomy, Special Courses—These subjects are optional for candidates for the degree of M.D., and are open to post-graduate students in medicine. They may be offered each as a minor for the degree of A.M.

149-150—Methods of Vital Statistics—1 hour. Optional. Professor BOAS.

In all courses offered in morphology the work is designed to be laboratory exercises of at least two continuous hours' duration at any one exercise, supplemented in certain courses by demonstration and study of material contained in the Museum of Human and Comparative Anatomy and in the study collections of the department.

The time required for the above courses if offered as minors for the degree of A.M. is half a day per week from October to April.

The courses are given on Tuesday afternoons at the Anatomical Laboratory, College of Physicians and Surgeons, by Professor HUNTINGTON and Dr. DARRACH.

By special arrangement other hours are assigned to work in the cases of advanced students and investigators.

The demands on laboratory space and teaching force rendered it necessary to limit the number of candidates admitted to these courses.

BACTERIOLOGY

Preliminary Statement

Candidates for A.M. and Ph.D. taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical elementary chemistry. No preliminary work in bacteriology.

There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoölogy in the Department of Zoölogy.

None of the courses in this department is open to women, nor to Seniors in Columbia College.

51—**Elementary Bacteriology**, especially adapted to the requirements of students of medicine, four hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. Professor HISS and Drs. WADSWORTH, ZINSSER, and HUMPHREYS.

Graduate Courses

201—**Special Laboratory Course in Advanced Bacteriology**—This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study and measurement of bacteria; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides; biological examinations of water, soil, air, foods, and industrial products.

During the last weeks of the course an opportunity is afforded to the student to elect some special division of the subject, sanitary, medical, or industrial, to which he will devote his time.

Text-books: Eyre's *Bacteriological Technique*, Kolle u. Wasser-

mann's *Handbuch d. Pathogenen Mikroorganismen*, Macé's *Bactériologie*.

The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon in November, December, and January. Professor HISS and Drs. WADSWORTH and ZINSSER.

Minor for one year for the degree of A.M. or Ph.D.

203—Advanced Bacteriology with Research—As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; practical work in photomicrography, and the pursuit of some selected theme for original investigation. Professor HISS and Drs. LEAMING and WADSWORTH.

Text-book: Kolle u. Wassermann's *Handbuch der pathogenen Mikroorganismen*.

Attendance and hours as in Course 201, with additional time for research.

Major for one year for the degree of A.M. or Ph.D.

Photography and Photomicrography

Practical instruction is given to a limited number of men in the photographic laboratories of the college, in the technique of photography and photomicrography. The time necessary for the acquirement of this technique varies with the facility of the student and the hours devoted to the theme, and is subject to special arrangement. Given in the Department of Pathology under the Medical Faculty.

The facilities in these laboratories may be drawn upon for purposes of record and illustration by instructors and investigators in various departments of the University. Dr. LEAMING.

Research

Research in bacteriology may be pursued in the laboratories of this department by a limited number of graduate students or practitioners of medicine or other advanced workers, under the direction of the professor. To such men the large collection of bacterial cultures belonging to this department are accessible. Professor HISS.

BIOLOGICAL CHEMISTRY

(Including Physical and Organic Chemistry, Physiological and Pathological Chemistry, Toxicological Chemistry, and Botanical Chemistry.)

51—Physical and Organic Chemistry—The course treats of the fundamental facts and theories of physical and organic chemistry.

Most of the time of the course is devoted to a study of the aliphatic derivatives. The constitution and relationships of leading groups of carbocyclic and heterocyclic compounds are also reviewed. Typical substances are made synthetically and the properties of substitution and addition products are ascertained experimentally. Fats, carbohydrates, and proteins are studied in considerable detail.

Throughout the course due consideration is given to the leading facts of physical chemistry, especially to the laws and theories relating to mass action, heat and chemical change, catalysis, osmosis, electrolytic dissociation and similar subjects of special significance for the student of medicine.

Course **51** is required, in the first half of the first year, of candidates for M.D., and is open as an elective to qualified Seniors of Columbia College.

The lectures and laboratory work are illustrated by numerous demonstrations. (First half-year.)

Lectures (the entire class, 2 per week). 1 hour. Recitations (each section [2] two per week). 1 hour. Laboratory exercises (each section [2] two per week). 3 hours. Professor GIES, Drs. STEEL and OLPP and Mr. LOTHROP.

102—General Physiological Chemistry—The course embraces a study of the chemical changes normally occurring in organisms, also of the constituents (and of the functions and uses of the constituents) of the tissues, secretions, etc. Among the various subjects considered experimentally are the tissues and organs, food, digestion, milk, urine, etc.

The recitations are so conducted as to review and more fully explain the results of the laboratory work and demonstrations. The lectures, however, are devoted mainly to such topics of a general nature as cannot well be brought up in the laboratory for direct experimentation or demonstration in the time allowed for the course.

Among the themes considered in the lectures are such as the physico-chemical nature of protoplasm and the contents of the cell, chemical reactions in the cell, respiration, metabolism, internal secretion, the chemical influences of micro-organisms in the body, chemical defences of the organism, etc.

In this treatment of chemical physiology the attention of the student is also directed from time to time to various related facts of a chemico-pathological character.

Course **102** is required, in the second half of the first year, of candidates for M.D., in continuation of course **51**. The course is open as an elective to qualified Seniors of Columbia College.

The lectures and the laboratory exercises are illustrated by numerous demonstrations. (Second half-year.)

Lecture (the entire class, weekly). 1 hour. Recitation (each section [2] two weekly). 1 hour. Laboratory exercises (each section [2] two per week). 3 hours. Professor GIES, Drs. FOSTER, MOSENTHAL, STEEL, OLPP, and Mr. LOTHROP.

104—Elementary Physiological Chemistry, etc., as given, page 137, University Catalogue.

201-202—Chemistry of Digestion and Assimilation—A lecture

course, with demonstrations, on general nutrition. Mondays. 1 hour. (School of Pharmacy.) Professor GIES.

203-204—Laboratory Course in Quantitative Physiological Chemistry—Numerous clinical methods are studied in detail. 6 hours. Professor GIES and Dr. STEEL.

205-206—Laboratory Course in Advanced Physiological and Pathological Chemistry—This course is arranged for students who wish to make a very thorough study of bio-chemical science. It particularly affords opportunity for experimental observations of the more intricate phases of chemical physiology and pathology, and terminates in original investigation under personal direction. 12 hours. Professor GIES.

207-208—Laboratory Course in Toxicological Chemistry—A study of methods for the detection and quantitative determination of alkaloids and other poisons. 6 hours. Professor GIES and Mr. EDDY.

209-210—Laboratory Course in the Chemical Physiology of Plants—A study of the chemistry of plant constituents.

The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is consulting chemist. 6 hours. Professor GIES.

In addition to the courses referred to above Professor GIES co-operates with Professor BURTON-OPITZ in giving Course 101-102 in Physiology.

301-302—Bio-chemical Seminar—The members of the teaching staff and all other investigators in the department meet weekly to study and discuss recent researches in chemical biology. The seminar is open to all students in the University. 2 hours. Professor GIES in charge.

Research—The laboratory is open to advanced workers for research carried on independently or under guidance. Professor GIES consults regularly with investigators in the Department of Zoölogy, and at the New York Botanical Garden, on Tuesday afternoons.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of the principles of general biology, and the subject-matter of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses, given below, the equivalent expected can be seen. For example, Courses 1-2, 3-4, 5, and 101-102 for men or Courses 51-52, 53-54, 153, and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject

presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through, which cannot possibly take less than two years (including work during two summers) for Ph.D. or one year for A.M.

Minor work in botany presupposes two years' preparation in the subject, with at least two full courses for Ph.D. or one full course for A.M.

All graduate courses are open to women.

1-2—Nature and development of plant life. C 2 and L 4 hours. Professor CURTIS and Mr. DARLING.

3-4—Plant morphology. C 2 and L 4 hours. Professor CURTIS and Mr. DARLING.

5—Problems in botanical technique. L 6 hours. Designed for teachers and medical students. Dr. CURTIS.

6—Economic botany. C 1, L 3 hours.

7—Growth and character of timber. C 1, L 3 hours. Professor CURTIS and Mr. DARLING.

101-102—Plant physiology. A course in experimental physiology supplemented by selected readings and conferences. 2 laboratory sessions. Professor CURTIS and Mr. DARLING.

113-114—Morphology of the higher plants. Study of the orders, including the structure and relationship of plants. Professor CURTIS and Mr. DARLING.

115-116—Morphology of the lower plants, with special reference to the structural features, diagnostic characters and relationships of the principal orders. Professor CURTIS and Mr. DARLING.

Courses in Barnard College

51-52—Principles of plant morphology and physiology. 5 hours, lectures, demonstrations, and laboratory work. Professor RICHARDS, Miss LATHAM and Miss KINGSLEY.

53-54—General morphology and development of plants. C 2, L 4 or 6 hours. Dr. HAZEN and Miss KINGSLEY.

55-56—Morphology and classification of spermatophytes—With practice in determination of species. C 1, L 4 or 6 hours. Dr. HAZEN.

[151-152—Bacteria and the lower fungi. C 1, L 6 hours.]

153—Anatomy of vascular plants. C 2 and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM.

154—Physiology of plants from standpoint of nutrition. C 2 and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM.

156—Physiology of plants from standpoint of growth. C 2 and a minimum of L 6 hours. Professor RICHARDS.

Courses 154 and 156 are given in alternate second half-years.

158—Structure and development of algæ—Advanced course. C 1, L 6 hours. Professor RICHARDS and Dr. HAZEN.

159—Structure and development of fungi—Advanced course. Professor RICHARDS. C 1, L 6 hours.

Courses 158 and 159 are not usually given the same year.

160—Developmental anatomy—Practice in methods of technique. Professor RICHARDS. 8 hours of laboratory work with occasional lectures and outside reading.

161-162—Advanced physiology and morphology. Professor RICHARDS and Dr. HAZEN. Work will be arranged to suit the needs of the students.

Graduate Courses

201-208—Physiology—Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. Professor RICHARDS and Professor CURTIS.

209-210—Physiology of nutrition—treated from a chemical standpoint. Professor RICHARDS and Professor GIES.

211-212—Plant pathology—Diseases induced by cryptogamic parasites, including work in culture methods. Dr. MURRILL and Mr. SEAVER.

217-218—Embryology of spermatophyta—With special work during two summers. Professor CURTIS and Dr. HAZEN.

219-226—Morphology—Work dealing with morphological problems in the various groups of plants. Directed by members of the department and Botanical Garden staff.

227-234—Taxonomy—Critical study of a family, genus, or other group selected from any division of the plant world. Directed by members of the Botanical Garden staff.

235-238—Plant Distribution—Problems dealing with regional botany or plant geography. Professor BRITTON and other members of the staff.

239-240—Developmental Taxonomy—Fossil ancestors of some family of plants. Dr. HOLLICK.

301-302—Seminar—A seminar is held monthly at the botanical laboratory in Schermerhorn for critical discussion.

Convention—A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See **Education 153-154, 183, 253-254** in

Teachers College Announcement. The same instructors also offer three elementary subject-matter courses in biology; see **Biology 53** and **58**, and **Nature-Study 1-2** in Teachers College Announcement.

PATHOLOGY

College of Physicians and Surgeons

General Pathology—Three exercises weekly of three hours each, consisting of a lecture followed by demonstration to illustrate the subject. Such demonstration may be in the form of physiological or chemical experiments, or of gross or microscopical exhibition and study of anatomical lesions, as may be best suited to elucidate the questions in hand. Second half-year. Dr. MACCALLUM and Assistants.

Gross Pathological Anatomy—Two hours one day a week. Demonstration and study of material from autopsies gathered during the week. Dr. MACCALLUM, Dr. LARKIN and Assistants.

Conference on General Pathology—One hour weekly—Dr. MACCALLUM.

Autopsy Demonstrations—These are carried out in various hospitals and are attended by small groups of students. Afternoons.

The above courses are open to candidates for the degree of M.D. or Ph.D.

Research Work—The laboratory is open for research under the direction of its officers, to advanced workers, who will find there excellent facilities for the investigation of pathological problems.

PHYSIOLOGY

College of Physicians and Surgeons

Candidates for the degree of M.D. are required to take Course 108-109.

Courses 103-104, 105-106, 107, 108-109, 111-112 are not open to women nor to students of Columbia College, except in so far as Course 108-109 is required of Seniors who are taking their first year in medicine.

Candidates for the degree of A.M. may take (a) Courses 103-104 and 105-106, or (b) in the first half-year, either Courses 109 and 107, or Course 107 with a sufficient amount of prescribed reading, and, in the second half-year, a course in Biological Chemistry.

Candidates for the degree of Ph.D. are expected to take during their first year Courses 103-104 and 105-106; during the first half of their second year, Course 107, with Course 109 or with a sufficient amount of prescribed reading; and during the second half of their second year a course in Biological Chemistry.

103-104—General Physiology—Structure of protoplasm; physiology of the cell; physiological division of labor and physiological integration;

chemistry of protoplasm; theory of solutions; osmosis; colloids; physical chemistry of the cell; irritability; contractility; the tropisms; secretion; structure and general functions of nerve-tissues; adaptation; Ehrlich's side-chain theory; antibodies. Lectures, 1 hour. Professor LEE.

105-106—Laboratory Course in General Physiology. 5 hours. Professor BURTON-OPITZ.

Open, in conjunction with Course 103-104, to qualified candidates for the degree of A.M., M.D., or Ph.D.

108-109—The Physiology of Man as Related to that of Other Mammals and of Lower Vertebrates—Lectures and demonstrations, 4 hours. Recitations, 1 hour; text-book, Howell's *Physiology*. Laboratory work, 3 hours. Professors CURTIS and BURTON-OPITZ, and Drs. EMERSON, SHEARER, BINGHAM, KEATOR, and YOCUM.

Open to qualified candidates for the degree of A.M. or Ph.D.

107—Laboratory Course in Special Physiology—3 hours during the first half-year. Professor CURTIS or Professor BURTON-OPITZ.

111-112—Electro-Physiology—Hours and work to be arranged with the instructor. Dr. CUNNINGHAM.

Research—The laboratories are open for research, under the direction of their officers, to advanced workers.

Columbia College

101-102—Elementary Physiology—Given with the coöperation of the Department of Biological Chemistry. C 1, L 2 hours. 516 S. Professor BURTON-OPITZ.

Department of Botany

The following courses deal with **Plant Physiology** and are given detailed reference under the Department of Botany, pp. 18-21. They include Courses Nos. 101 and 102, General Plant Physiology (Dr. C. C. CURTIS); 201-208, Advanced Physiology (Professor RICHARDS and Dr. C. C. CURTIS); 209-210, Physiology of Nutrition. Professor RICHARDS and Professor GIES.

Barnard College

A course in general **Animal Physiology** is given by the Department of Zoölogy of Barnard College, supplementing the work in general Biology and Zoölogy. (See p. 25.) Miss REED.

Three courses in **Plant Physiology** are given by the Department of Botany of Barnard College (see p. 19): One dealing with Plant Nutrition, **Botany 154**, a second with Growth, **Botany 156**, a third with advanced problems in physiology, **Botany 161-162**. All given by Professor RICHARDS.

COURSES IN ZOOLOGY

Graduate major work in zoölogy requires at least two years of preparatory undergraduate study, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses 1-4 and 91-92, to which may with advantage be added 5 and 94. For minor or special graduate work a less extensive preparation may suffice, but all candidates for the higher degrees must have taken at least one year's work in zoölogy or elementary biology. Of the following courses, 1-2, 3-4, 5, 91-92, and 94 are for undergraduates only.

In general less stress is laid on the completion of formal course-work for the higher degrees than on the attainment of an appropriate standard of knowledge and training, of which the best evidence is given by the master's thesis or the doctor's dissertation. The following examples of the course-work are not given as fixed requirements, but in order to illustrate some of the combinations of courses that may be taken.

Towards an A.M. major, students may take the equivalent of two one-day courses for one year; examples, 201 (two-day half-year course), 203-204, 215-216, 221-222 and 223-224 (one-day year courses) with any two of 106, 220, 206, 212, 213, 217, 218 (one-day half-year). Students who have not taken 91-92 as undergraduates may take 101-102 as the equivalent of an A.M. minor, but this course will not be accepted as part of major work in zoölogy.

The Ph.D. minor represents approximately the amount of work required for an A.M. major, though in either case specially assigned study or research (to be registered as Course 207) may in part take the place of formal course-work. For the Ph.D. major no fixed rule can be laid down, but in general the regular work may be roughly estimated as at least twice that required for a minor. Courses 201 and 223-224 are recommended to all Ph.D. major students as a general foundation. For a minor, Course 101-102 (or an equivalent) may constitute one-half the requirement in the case of students who have not taken 91-92 as undergraduates; for the remaining half any one of the full-year courses or any two of the half-year courses (as indicated above) may be taken. Students who have taken Course 91-92 as undergraduates may take in addition the equivalent of an A.M. major as specified above.

All of the graduate courses are open to women.

Courses in Columbia College

1-2—Elementary Biology (Zoölogy)—Introductory to the general principles of biology and to animal morphology and physiology. This

course is designed for students taking a year of science as part of a general course or in preparation for the study of medicine; it also forms a foundation-course for all the other courses in the department.

In this course a detailed study of a series of living forms is made the basis for brief discussions of essential principles. Text-books: Sedgwick and Wilson's *General Biology*, Marshall and Hurst's *Practical Zoölogy*. Reference books: Parker's *Elementary Biology*, Jordan and Kellogg's *Animal Life*, Osborn's *Greeks to Darwin*, and Marshall's *Vertebrate Embryology*.

Open to all undergraduates who have had entrance chemistry and physics or Science A. C 2, L 4 hours.

Courses 3-4 may with advantage be taken with 1-2 to form a more comprehensive course.

First Half-year.

1—Elementary Biology and Invertebrate Zoölogy—Two exercises a week. General introduction. Protoplasm and the cell. General biology of the animal and plant. Unicellular organisms; Amœba, Pleurococcus, yeast, bacteria, infusoria. The comparative study of a series of types illustrating the outlines of invertebrate zoölogy. Professors CALKINS and MCGREGOR. 619 S.

2—Elementary Zoölogy (vertebrates)—The comparative study of a series of vertebrate types with brief discussions of the main problems of evolution and heredity. Two exercises a week. Professors DEAN and MCGREGOR. 619 S.

3—Elementary Histology—General study of animal cells and tissues. One exercise a week. Professor MCGREGOR. 619 S.

4—Elementary Embryology—One exercise a week. Development of the frog and chick. Professor MORGAN. 619 S.

5—General Biology—Lectures, conferences, and laboratory work on the general principles of biology: variation, inheritance, evolution, geographical distribution, animal coloration and related topics.

This course supplements the general discussions given in Courses 1-2 and 91-92 and gives opportunity for a more critical and extended treatment of general principles. One afternoon. Professor WILSON.

Prerequisite: 1-2.

91-92—General Zoölogy—Vertebrate and invertebrate zoölogy, including anatomy, embryology, and etiology (natural environment, terrestrial and marine faunal areas, principles of distribution). This course directly continues the work of Courses 1-4, and is designed to give a broad, general acquaintance with the principles of zoölogy and comparative morphology. It is recommended to students looking forward to teaching and research or to the study of medicine, and to others whose courses are mainly in the natural sciences.

91—Comparative morphology, classification, and general zoölogy of invertebrates. Text-book: Parker and Haswell, *Zöology*, Vol. I. C 3, L 6 hours. Professor MCGREGOR. 619 S.

92—Classification and comparative anatomy of the main living orders of fishes, amphibians, reptiles, birds, and mammals. Practical study of the skeleton, integument, muscles, nerves, viscera. Text-book: Parker and Haswell, *Zoölogy*, Vol. II. *C* 3, *L* 6 hours. Professor MCGREGOR. 619 S.

94—Embryology of Vertebrates—An examination of the characteristic stages of fishes, amphibians, reptiles, birds and mammals. Embryological technique. Text-book: Mark's Hertwig's *Vertebrate Embryology*. *C* 1, *L* 2 hours. Professor MCGREGOR. 619 S.

101-102—General Zoölogy—This course covers the same general ground as 91-92, but is supplemented by additional assigned work. It may not be counted as part of the major work towards the higher degrees. Professor MCGREGOR. Three lectures, six hours laboratory throughout the year.

106—Cellular Biology—General structure and functions of the cell. 6 hours (one day a week). Professor WILSON.

Open to graduates and to undergraduates who have had at least two years of study in Zoölogy.

110—The Parasitic Protozoa—A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. 6 hours (one day a week). Professor CALKINS.

Courses in Barnard College

1-2—General Biology and General Zoölogy—Elementary course. Professor CRAMPTON, Dr. OSBURN, Miss DEDERER, and Miss REED. *C* 2, *L* 4 hours.

3—Histology—*C* 1, *L* 2 hours.

4—Embryology—*C* 1, *L* 2 hours.

5—General Biology—The general principles of biology: variation, inheritance, evolution, geographical distribution, animal coloration, and related topics. Professor CRAMPTON. 3 hours *C* and *L*.

91-92 and 101-102—General Zoölogy—Advanced course. Professor CRAMPTON, Dr. OSBURN, and Miss REED. *C* 3, *L* 6 hours.

151-152—General Physiology—General principles of animal physiology. Miss REED. *C* 2, *L* 4 hours.

153-154—Practical Zoölogy and Embryology—Miss DEDERER. 3 hours *C* and *L*.

Graduate Courses

A. Comparative Zoölogy

The two following courses are designed to complete the work in general zoölogy begun in 1-2 and continued in 91-92, and are recommended to all students making zoölogy their major subject. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

201—Topics in Invertebrate Zoölogy, with especial reference to problems of phylogeny. 2 days a week. Professor WILSON.

223-224—Evolution of the Vertebrates, especially phylogenetic relations, adaptations, and broader classification of the principal groups—Designed for students of zoölogy, paleontology, and geology. The paleontological collections of the American Museum are used to illustrate this course. 1 day a week throughout the year. Lectures and laboratory work. Professors OSBORN, MCGREGOR and Mr. GREGORY.

B. Embryology and Cellular Biology

208-209—Comparative Embryology (see also 4 and 94)—Facts and principles of animal development.

208—Embryology (with special reference to comparative organogeny) of the **Main Vertebrate Types**—Demonstrations and reading. 1 day a week. Professor DEAN.

209—General Embryology of Invertebrate Types—Special reading and laboratory work. 1 day a week. Professor CALKINS.

220—Cellular Embryology (see also 106 and 218)—A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. One lecture a week with reading, conferences, and specially arranged laboratory work. Courses 94 and 208-209 form a desirable preparation. This and 218 are parallel courses which supplement each other. Professor WILSON.

C. Morphology and Evolution of Special Groups

203-204—Mammals, Living and Fossil—Lecture and laboratory course. A study of the principles of the evolutionary history and adaptation, of the morphology and classification of living and fossil mammals. The lectures for this course will not be given during 1909-10, but properly qualified graduate students may register for research work. Professor OSBORN and Mr. GREGORY. The course is largely given in the American Museum of Natural History. Reference books: Weber's *Die Säugetiere*, Flower and Lydekker's *Mammals*.

206—Fishes, Living and Fossil—This course considers especially the phylogenetic relations of the sub-classes and orders of fishes. C 1, L 2 hours. Professor DEAN.

D. Protozoölogy

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life history, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

221-222—Protozoölogy—A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology, and physiology. 6 hours (one day) a week. Professor CALKINS.

See also 110—Parasitic Protozoa.

E. Experimental Zoölogy

The following six courses (213-218) cover three years of one day a week. Each course may be taken independently of the others and not necessarily in the order given.

215-216—Experimental Zoölogy—This course includes a treatment of such questions as the influence of external conditions in modifying species and in affecting modes of reproduction, the influence of hybridization, the rate of growth as affected by the environment, the determination of sex. One lecture a week, with laboratory work on special problems. Professor MORGAN.

217—Experimental Study of Regeneration—The phenomena of regeneration are studied as bearing on the problem of growth. A principal feature of this course is the formulation of special problems for further investigation. One lecture a week. Professor MORGAN.

218—Experimental Embryology—The influence of external factors on normal development. This course is parallel to 220, which treats of internal factors. One lecture a week. Professor MORGAN.

213—Experimental Study of Reflex Actions and Tropisms—This course deals with the simpler responses of organisms to external factors and serves as an introduction to the next course, 214. One lecture a week.

214—Experimental Study of Instincts—An analysis of the more complex behavior of animals, and the problems of the evolution of instincts. One lecture a week.

212—The Experimental Study of Evolution—With special reference to the statistical study of variation and inheritance. One lecture a week, with readings and conferences. Professor CRAMPTON.

F. Research

207—Zoölogical Research—Investigation of special problems in any of the subjects enumerated above.

Course in the College of Physicians and Surgeons

51-52—Practical Instruction in Histology and Embryology. 7½ hours. Professor BAILEY and Drs. STRONG, MILLER, BANKER, and SMITH.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See **Education 153-154, 183, 153-254** in Teachers College Announcement. The same instructors also offer three elementary subject-matter courses in biology; see **Biology 53 and 58, and Nature-Study 1-2** in Teachers College Announcement.

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Columbia University Bulletin of Information

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DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PATHOLOGY, PHARMA-
COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1913-1914

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(Issued 25 times during the Academic year, monthly in November and December, and weekly between February and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under Act of July 16, 1894.)
These include:

1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, issued in December, price 25 cents.
3. The Announcements of the several Colleges, and Schools and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University. For information as to the various courses offered by the University consult the last page of this Announcement.

B—1913—1500—T.H.

ABRIDGED ACADEMIC CALENDAR

The Academic year is thirty-seven weeks in length, ending on the second Wednesday in June. In 1913-14 the year begins on September 24, 1913, and ends on June 10, 1914. It is divided into two half-years. In 1913-14 the second half-year begins on February 4, 1914. The Summer Session for 1914 begins on July 6 and ends on August 14.

The exercises of the University are suspended on Election Day, Thanksgiving Day, and the following two days, for two weeks at Christmas, on Washington's Birthday, from the Thursday before Good Friday through the following Monday, and on Memorial Day.

The complete Academic Calendar will be found in the University Catalogue, and so far as it refers to the students studying under any Faculty, in the Announcement of that Faculty.

OFFICERS OF THE DIVISION OF BIOLOGY

- GEORGE S. HUNTINGTON.....*Professor of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D.,
Jefferson Medical College, 1907.
- EDMUND B. WILSON.....*Da Costa Professor of Zoölogy*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902;
LL.D., Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.), Leipsic, 1909;
Member of National Academy of Sciences.
- FREDERIC S. LEE.....*Dalton Professor of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN.....*Professor of Vertebrate Zoölogy*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D.,
1890; Chevalier de la Légion d'Honneur, 1910.
- HENRY E. CRAMPTON.....*Professor of Zoölogy*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES.....*Professor of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS...*Professor of Botany and Secretary of the*
Division
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS.....*Professor of Protozoölogy*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.
- MAURICE A. BIGELOW.....*Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- RUSSELL BURTON-OPITZ.....*Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN.....*Professor of Experimental Zoölogy*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; Member
of National Academy of Sciences.
- JOHN HENRY LARKIN.....*Assistant Professor of Pathology*
A.B., Manhattan, 1891; M.D., Columbia, 1894.
- JAMES HOWARD MCGREGOR.....*Assistant Professor of Zoölogy*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- HERMANN VON W. SCHULTE.....*Associate Professor of Anatomy*
A.B., Trinity, 1897; M.D., Columbia, 1902.
- CARLTON CLARENCE CURTIS.....*Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.
- WILLIAM G. MACCALLUM.....*Professor of Pathology*
A.B., Toronto, 1894; M.D., Johns Hopkins, 1897.
- TRACY E. HAZEN.....*Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.

- RAYMOND C. OSBURN.....*Assistant Professor of Zoölogy*
B.S., Ohio State, 1898; M.S., 1900; Ph.D., Columbia, 1906.
- ROBERT A. HARPER.....*Torrey Professor of Botany*
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences.
- WILLIAM G. MARQUETTE.....*Associate Professor of Botany*
Ph.G., Northwestern, 1899; B.S., Wisconsin, 1903; Ph.D., 1907
- FRANK HENRY PIKE.....*Assistant Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- PAUL E. HOWE.....*Assistant Professor of Biological Chemistry*
B.S., Illinois, 1906; A.M., 1907; Ph.D., 1910.
- ADAM M. MILLER.....*Assistant Professor of Anatomy*
A.B., Princeton, 1901; A.M., 1902.
- CHARLES C. LIEB.....*Assistant Professor of Pharmacology*
A.B., Columbia, 1902; M.D., 1906.
- HANS ZINSSER.....*Professor of Bacteriology*
A.B., Columbia, 1899; A.M. and M.D., 1903.
- JAMES W. JOBLING.....*Assistant Professor of Pathology*
- ALWIN M. PAPPENHEIMER.....*Associate in Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY.....*Associate in Anatomy*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- WALTER H. EDDY.....*Associate in Biological Chemistry*
B.S., Amherst, 1898; A.M., Columbia, 1908; Ph.D., 1909.
- HORATIO B. WILLIAMS.....*Associate in Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- ROBERT A. LAMBERT.....*Associate in Pathology*
M.D., Tulane, 1907.
- WILLIAM K. GREGORY.....*Associate in Zoölogy*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- ALFRED P. LOTHROP.....*Associate in Biological Chemistry*
A.B., Oberlin, 1906; A.M., 1907; Ph.D., Columbia, 1909.
- OLIVER S. STRONG.....*Instructor in Anatomy*
A.B., Princeton, 1886; A.M., Columbia, 1892; Ph.D., 1896.
- PAULINE H. DEDERER.....*Instructor in Zoölogy in Barnard College*
A.B., Columbia, 1901; A.M., 1907.
- MARION E. LATHAM.....*Instructor in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- CHESTER A. DARLING.....*Instructor in Botany*
A.B., Albion, 1904; A.M., 1906; Ph.D., Columbia, 1909.
- LOUISE H. GREGORY.....*Instructor in Zoölogy in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.

- LEANDER H. SHEARER.....*Instructor in Physiology*
A.B., Princeton, 1897; M.D., Columbia, 1901.
- JAMES G. DWYER.....*Instructor in Bacteriology*
M.D., Queen's, 1905.
- WILLIAM K. TERRIBERRY.....*Instructor in Physiology*
A.B., Yale, 1903; M.D., Columbia, 1907.
- HERMAN O. MOSENTHAL.....*Associate in Biological Chemistry*
A.B., Columbia, 1899; M.D., 1903.
- MAX KAHN.....*Associate in Biological Chemistry*
M.D., Cornell, 1910; A.M., Columbia, 1911; Ph.D., 1912.
- FREDERIC G. GOODRIDGE.....*Instructor in Biological Chemistry*
A.B., Harvard, 1897; M.D., Columbia, 1901.
- DONALD GORDON.....*Instructor in Physiology*
M.D., Columbia, 1906.
- ALFRED J. BROWN.....*Instructor in Anatomy*
A.B., Yale, 1899; M.D., Columbia, 1903.
- JOHN C. VAUGHAN.....*Instructor in Anatomy*
M.D., Columbia, 1907.
- JEAN BROADHURST.....*Instructor in Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908.
- CAROLINE STACKPOLE.....*Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- EMILY C. SEAMAN.....*Instructor in Household Arts in Teachers College*
B.S., Adelphi, 1899; A.M., Columbia, 1905; Ph.D., 1912.
- ERNEST L. SCOTT.....*Instructor in Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911.
- JAMES CLAYTON SHARP.....*Instructor in Anatomy*
M.D., Columbia, 1901.
- FORDYCE B. ST. JOHN.....*Instructor in Anatomy*
B.S., Princeton, 1905; M.D., Columbia, 1909.
- LOUIS E. WISE.....*Instructor in Biological Chemistry*
A.B., Columbia, 1907; Ph.D., 1911.
- J. VICTOR HABERMAN.....*Instructor in Neurology and in Psycho-
Therapeutics*
A.B., Columbia, 1903; M.D., 1905.
- HAROLD E. B. PARDEE.....*Instructor in Physiology*
A.B., Columbia, 1906; M.D., 1909.
- ANTHONY C. FREEMAN.....*Instructor in Pharmacology*
A.B., Stanford University, 1906; M.D., Columbia, 1910.
- BERNARD O. DODGE.....*Research Assistant in Botany*
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- ALBERT R. LAMB.....*Assistant in Pathology*
A.B., Yale, 1903; M.D., Columbia, 1907.

- HARRIS MOAK.....*Assistant in Bacteriology*
M.D., Albany Medical College, 1899.
- ARTHUR KNUDSON.....*Assistant in Biological Chemistry*
A.B., Missouri, 1912.
- CYRUS W. FIELD.....*Assistant in Pathology*
- MARY W. STEWART.....*Assistant in Botany in Barnard College*
A.B., Columbia, 1913.

Members of the Staff of the Botanical Garden Giving Instruction in the Division

- NATHANIEL LORD BRITTON, Ph.D., Sc.D.....*Director*
- WILLIAM ALPHONSO MURRILL, Ph.D.....*Assistant Director*
- ARLOW BURDETTE STOUT, Ph.D.....*Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D.....*Head Curator of the Museums*
- FRED. JAY SEAVER, Ph.D.....*Curator*
- PER AXEL RYBERG, Ph.D.....*Curator*
- ARTHUR HOLLICK, Ph.D.....*Curator*
- MARSHALL AVERY HOWE, Ph.D.....*Curator*
- GEORGE VALENTINE NASH.....*Curator of the Plantations*
- HENRY HURD RUSBY, M.D.....*Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D.....*Consulting Chemist*

Partial Courses are also Given by

- ELIZABETH GERTRUDE BRITTON EDWARD SANFORD BURGESS, Ph.D.

University Officers of Administration

- FRANK DIEHL FACKENTHAL, A.B.....*Secretary of the University*
- FRANK A. DICKEY, A.B.....*Registrar of the University*
- CHARLES S. DANIELSON.....*Bursar*
- HENRY L. NORRIS, M.E.....*Superintendent of Buildings and Grounds*
- MALCOLM M. ROY, A.B.....*Secretary of Appointments*

Chaplain of the University

REV. RAYMOND C. KNOX, B.D.

Medical Director of the Gymnasium

GEORGE L. MEYLAN, M.D.

Secretary of Earl Hall

RUBEN A. MEYERS, A.B.

University Medical Visitor

D. STUART DODGE JESSUP, M.D.

Health and Sanitary Officer

WM. H. MCCASTLINE, M.D.

GENERAL STATEMENT

Introductory

The Division of Biology includes the departments of Anatomy, Bacteriology, Biological Chemistry (Nutrition), Botany, Pathology, Physiology, Pharmacology, and Zoölogy in all schools of the University.

Students in this Division are received as candidates for the degrees of Master of Arts and Doctor of Philosophy under the Faculty of Pure Science. Certain courses which may be counted toward these degrees are also offered in the Summer Session and in Extension Teaching. (See separately printed announcements.)

For details of admission, registration, degrees, fees, fellowships, scholarships, prizes, student employment, dormitories, expense of living and public lectures, see the appropriate announcement either of the Faculties of Political Science, Philosophy and Pure Science, or of Columbia, Barnard, or Teachers College, any of which may be had on application to the Secretary of the University.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those granted to men.

The following special regulations of the Faculty of Pure Science should have the attention of students under that Faculty.

The candidate for the degree of Master of Arts is expected to do the major part of his work in some one Department and to consult with a professor of that Department concerning the entire combination of courses to be pursued.

The candidate for the degree of Doctor of Philosophy is required to select a major and two minor subjects, but with the consent of the Dean, the major and one minor subject may be taken under one Department. Both minor subjects may not be taken under one Department without the consent of the Faculty of Pure Science.

The student is expected to gain a sound general knowledge of the minor subjects of his choice. In the major subject a much more thorough and special knowledge is required, particular importance being attached to training in research.

The approval of the subject of the essay for the degree of Master of Arts and of the dissertation for the degree of Doctor of Philosophy rests with the instructor in charge of the candidate's major subject. It is desirable that the studies upon which the essay and the dissertation are based should be related, and when practicable, that they should be treated respectively as preliminary and completed investigations. It is not necessary, however, to acquire the degree of Master of Arts, and candidates for the degree of Doctor of Philosophy may register directly for it at matriculation. Great importance is attached to the character of the final dissertation. While it must depend for acceptance chiefly on the subject-matter, it should show good literary workman-

ship, especially by directness and clearness of statement. It should demonstrate the author's capacity to do original scientific work and to render an intelligible account thereof. It should evince a familiarity with the literature of the subject and with the latest methods of research. The treatment should be as concise as the nature of the work permits. Every dissertation should be preceded by a clear introductory statement, setting forth the nature and the scope of the research, and be followed by a summary of the results and the conclusions obtained. It should also be accompanied by a table of contents and by a list of the authorities consulted in its preparation.

Fellowships and Scholarships

There are twelve University Fellowships, of an annual value of \$650 each, and in addition three specially endowed fellowships open to advanced students in biological research; twenty-four University Scholarships, including four open to women, of an annual value of \$150 each. There is a special scholarship in biology amounting to \$200 maintained by the Wawepex Society. This includes the use of a biological table at Cold Spring Harbor, Long Island.

Funds and Prizes

Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the Division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy

The laboratory for advanced morphological research occupies the third story of the Anatomical Building. Every facility for advanced and research work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology

The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College. It comprises a large laboratory for the accommodation of the undergraduate and advanced

classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media and for the chemical study of bacterial products. The laboratories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

BIOLOGICAL CHEMISTRY

(Nutrition)

At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor Gies' library occupies a room adjoining the laboratory and is accessible by appointment to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have been provided at the New York Zoölogical Park for research in biological chemistry, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students of biological chemistry.

Botany

The Department of Botany occupies the third floor of Schermerhorn, and the laboratories and lecture-rooms are thoroughly equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultra violet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammmeters, resistance measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus afford facilities for experimental work in physiology and pathology and pro-

vides living material under the most favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University the Botanical Garden supplies all needed facilities for research for members of the staff and for properly accredited students. This combination of forces not only places the Department of Botany within reach of material, equipment and collections not otherwise available, but opens up facilities for research work under conditions that are not excelled.

The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. Ample opportunity for experimental work in plant breeding and in plant pathology is afforded by the open-air plantations and extensive horticultural houses.

The Columbia herbarium and the equally extensive collections of the New York Botanical Garden are housed in the large room in the east wing of the Botanical Museum. The cryptogamic collections are arranged in special rooms. The entire aggregation of collections available for students is exceptionally full in every group of plants.

The library comprises over 20,000 volumes in addition to complete sets of the important botanical journals, which now number over one hundred.

A seminar for the study of special subjects in general physiology meets weekly and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a biweekly colloquium.

Pathology

The Department of Pathology occupies the greater part of the fourth floor of the north building of the College, together with large class laboratories, amphitheatre, photographic rooms, etc., on the fifth floor. On the fourth floor there are, besides the rooms devoted to the staff, large rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a small chemical laboratory, the museum, preparation rooms, cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is commodious accommodation for animals, together

with small special rooms for experimental work. The entire space is amply lighted, fully furnished and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology

The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises one large laboratory, which is provided with special apparatus for teaching purposes; one large and four small laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a specially endowed and very full collection of apparatus of precision, mainly for research; a library containing complete sets of all of the physiological journals, monographs and other books, and many reprints of special articles: two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoölogy

The zoölogical laboratories on the upper floor of Schermerhorn comprise a large general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoölogy, and eight rooms for private research, besides special rooms for supplies, aquaria, and preparation. There is also a commodious lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the great collections of the American Museum of Natural History (see below), the department does not maintain a general zoölogical museum. The equipment includes, however, a good teaching collection of animals, anatomical preparations, chart and wax models and an aquarium room in which a variety of living animals and plants are kept.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, a part of the University library kept in the laboratory, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes the journals and a rapidly increasing collection of

special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. Most of the current biological journals are subscribed for. The valuable libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains very extensive collections illustrating the zoölogy and palæontology of invertebrates and vertebrates, both from the systematic and bionomic point of view. The exhibition halls are always open to students, and certain of the University lectures and certain courses of research are conducted in the museum.

The Zoölogical Park in the Borough of the Bronx, under the direction of the New York Zoölogical Society, affords exceptional opportunities for the study of living reptiles, birds, and mammals. The park is under the general direction of Director William T. Hornaday, to whom applications should be addressed.

The New York Aquarium, also under the management of the Zoölogical Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a complete fish hatchery, which is in operation all the year round. Application should be made to Director Charles H. Townsend.

One of the special features of the department is the Journal Club, open to instructors and all advanced students, and meeting every week in the departmental library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

A weekly seminar open to all members of the department is from time to time carried on, for the more thorough discussion of some one selected topic of general interest.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former three investigators' rooms are subscribed for by the University for the use of the Department of Zoölogy; in the latter a table is available through the John D. Jones Scholarship. Circulars of the summer courses are obtainable in the department. The University also maintains an investigators' table at the Naples Zoölogical Station, for which application may be made to Professor E. B. Wilson. In addition to the above facilities, field expeditions are from time to time sent out by the department.

Publications by Members of the Division

The University Press issues the *Columbia University Biological Series*, a number of educational volumes originally founded upon public lectures, of which ten have already appeared and another is in press.

Another feature in advanced instruction is the connection with the biological section of the New York Academy of Sciences, which affords opportunities for reading, discussing, and printing scientific papers.

Two series of publications are issued from the Department of Botany: a quarto series known as the *Memoirs of the Department of Botany*, of which two volumes have been published; and the *Contributions from the Department of Botany*, in octavo, which have commenced on the tenth volume.

Collected reprints of biochemical studies, entitled *Biochemical Researches*, are issued at irregular intervals from the Biochemical Department. The Columbia University Biochemical Association, consisting of past and present workers in the Biochemical Department, publishes the quarterly *Biochemical Bulletin*.

The Department of Physiology issues from time to time volumes of collected reprints with the title, "Studies from the Department of Physiology of Columbia University."

The *Columbia University Quarterly* contains each year reports of the work of the several departments in this division.

COURSES OF INSTRUCTION

ANATOMY

101—Histology and Embryology. Lectures, conferences and laboratory work 12 hours; first half-year. Professors SCHULTE and MILLER and Drs. STRONG and SHARP. Double course.

103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences and dissections 12 hours. Drs. BROWN and VAUGHAN.

105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work and dissection 12 hours; first half-year. Drs. TILNEY, STRONG and ST. JOHN. Double course.

107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations 3 hours; first half-year. Professor HUNTINGTON. Half course.

202—Morphology of the Heart and Vascular System. 3 hours; second half-year. Professors HUNTINGTON, SCHULTE and staff. Half course.

204—Morphology of the Genito-urinary System. 3 hours; second half-year. Professors HUNTINGTON, SCHULTE and staff. Half course.

206—Morphology of the Respiratory Tract. 3 hours; second half-year. Professors HUNTINGTON, SCHULTE and staff. Half course.

208—Morphology of the Alimentary Canal. 3 hours; second half-year. Professors HUNTINGTON, SCHULTE and staff. Half course.

210—Morphology of the Nervous System. 3 hours; second half-year. Dr. TILNEY. Half course.

212—Histology of the Alimentary Canal and Its Derivatives. 3 hours; second half-year. Professors SCHULTE and MILLER and Dr. SHARP. Half course.

251-252—Research in Anatomy. Under the direction of the professor of anatomy. The officers of the department.

302—Seminar in Histology and Embryology. 1 hour; second half-year. Professor SCHULTE.

149-150—Methods of Vital Statistics. 1 hour. Optional. Professor BOAS.

The demands on laboratory space and teaching force render it necessary to limit the number of candidates admitted to these courses.

BACTERIOLOGY

Preliminary Statement

Candidates for A.M. and Ph.D. taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical elementary chemistry. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoölogy in the Department of Zoölogy.

Courses 201 and 203 are open to women.

101—General Bacteriology, especially adapted to the requirements of students of medicine. 6 hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. Professor ZINSSER and Drs. DWYER and MOAK. Full course.

201—Advanced Bacteriology. This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study and measurement of bacteria; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; methods

of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides; biological examinations of water, soil, air, foods, and industrial products.

During the last weeks of the course an opportunity is afforded to the student to elect some special division of the subject, sanitary, medical, or industrial, to which he will devote his time.

Text-books: Hiss and Zinsser's Text-book of Bacteriology, Kolle u. Wassermann's Handbuch d. Pathogenen Mikroorganismen, Macé's Bacteriologie.

The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon in October, November, December and January. Professor ZINSSER and Dr. DWYER.

Minor for one year for the degree of A.M. or Ph.D.

203—Special Bacteriology. As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; practical work in photomicrography, and the pursuit of some selected theme for original investigation. Professor ZINSSER.

Text-books: Hiss and Zinsser's Text-book of Bacteriology, Kolle u. Wassermann's Handbuch der Pathogenen Mikroorganismen.

Attendance and hours as in Course 201, with additional time for research.

Major for one year for the degree of A.M. or Ph.D. Double course.

205-206—The Principles of Infection, Immunity, Serum Diagnosis and Therapy. Lectures with demonstrations 1 hour. Professor ZINSSER.

208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twelve students. Professor ZINSSER.

251-252—Research in Bacteriology. Under the direction of the professor of bacteriology. The officers of the department.

Summer Session

S101—General Bacteriology. 2 points, equivalent to Course 101. Professor ZINSSER.

Course in Teachers College

A course in bacteriology applied to household arts is given in Teachers College by Miss Broadhurst.

BIOLOGICAL CHEMISTRY

(Nutrition)

Courses in Nutrition (Physiological and Pathological Chemistry)

102—General Physiological Chemistry. A course in the elements of normal nutrition. The course will present the essential chemical facts pertaining to life processes. Full course.

The recitations are so conducted as to review and more fully explain the results of the laboratory work and demonstrations. The lectures, however, are devoted mainly to such topics of a general nature as cannot well be brought up in the laboratory for direct experimental study or demonstration in the time allowed for the course.

In this treatment of chemical physiology the attention of the student is also directed from time to time to various related facts of a chemico-pathological character. The lectures and the laboratory exercises are illustrated by numerous demonstrations. 7 hours.

Course 102 is required, in the second half of the first year, of candidates for M.D., in continuation of course 101. The course is open as an elective to qualified Juniors and Seniors of Columbia College.

Professors GIES and HOWE, Dr. WISE and Mr. KNUDSON.

Course 102 is the equivalent of Courses 101-102, which are given at Teachers College by Professor GIES and Miss SEAMAN.

201-202—Chemistry of Nutrition. (School of Pharmacy. Required of candidates for the degree of Doctor of Pharmacy.) C 1 hour. Professor GIES.

203-204—General Biological Chemistry. Specially adapted to the needs of secondary school teachers of Biology. C 1 hour, L 4 hours. Dr. EDDY.

205-206—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Household Arts.) C 1 hour, L 5 hours. Professor GIES and Miss SEAMAN.

207-208—Biochemical Methods of Research, including Clinical Methods. C 1 hour, L 7 hours. Professor GIES, and Dr. LOTHROP, and Mr. MILLER. Two full courses.

209-210—Nutrition in Health and Disease. C 2 hours. Professors GIES and HOWE, and Drs. MOSENTHAL, KAHN and GOODRIDGE.

211-212—Nutrition in Health (advanced physiological chemistry). C 2 hours, L 14 hours. Professors GIES and HOWE. Two full courses.

213-214—Nutrition in Disease (general pathological chemistry). C 2 hours, L 14 hours. Professors GIES and HOWE. Two full courses.

251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 16 hours. Professors GIES and HOWE.

Toxicological Chemistry

217-218—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L 6 hours. Professor GIES. Two full courses.

Botanical Chemistry

219-220—Chemical Physiology of Plants. C 1 hour, L 7 hours. Professor GIES and Dr. CLARK. Two full courses. (The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is consulting chemist.) See Botany, page 17.

Bacteriological Chemistry

221-222—Chemistry of Micro-organisms; Fermentations, Putrefactions, and Enzyme Actions in General (introduction to sanitary chemistry). C 1 hour, L 7 hours. Professor GIES. Two full courses.

Sanitary Chemistry

105—Sanitary Chemistry. (Teachers College, Household Arts, 26a.) C 1 hour, L 3 hours. Professor GIES, Miss SEAMAN and Miss HARKEY. Half course.

Seminar

301-302—The members of the teaching staff, Ph.D. candidates and all other investigators in the department meet weekly to discuss results of recent researches in chemical biology. 1 hour. Professor GIES.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance. Professor GIES consults regularly with investigators in the Laboratory of Zoölogy on Tuesday afternoons, and at the N. Y. Botanical Garden on Wednesday afternoons.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4 and 101-102 for men or Courses 51-52, 53-54, 153 and 154 or 156 for women might be taken for a minimum, although

sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

Minor work in botany presupposes two years' preparation in the subject, with at least two full courses for Ph.D. or one full course for A.M.

All graduate courses are open to women.

1-2—General Botany. C 2 and L 4 hours. Professor CURTIS and Dr. DARLING.

3-4—Plant Morphology. C 2 and L 4 hours. Professor HARPER.

5—Forest Botany. L 6 hours. Dr. DARLING.

6—Economic Botany. C 1 hour, L 3 hours. Dr. DARLING.

7—Growth and Character of Timber. C 1 hour, L 3 hours. Professor CURTIS and Dr. DARLING.

9-10—Botanical Problems. Introductory to research. Professors HARPER, CURTIS and MARQUETTE.

101-102—Plant Physiology. C 2 hours, L 6 hours. Professor MARQUETTE. Double course.

113-114—Morphology of the Higher Plants. Study of the orders, including the structure and relationship of plants. Professor CURTIS, Dr. DARLING. Double course.

115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. Professor HARPER. Full course.

117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. Professor HARPER. Double course.

120—Plant Reactions. Lectures and demonstrations on the responses of plants to external stimuli. Professor MARQUETTE. Half-course.

201-208—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. Professors RICHARDS, CURTIS and MARQUETTE.

209-210—Physiology of Nutrition—treated from a chemical standpoint. Professors RICHARDS and GIES.

211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. Professor HARPER, Dr. MURRILL and Dr. SEAVER.

217-218—Embryology of Spermatophyta. With special work during two summers. Professors CURTIS and HAZEN.

219-226—Morphology. Work dealing with morphological problems in the various groups of plants. Directed by members of the department and Botanical Garden staff.

227-234—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. Directed by members of the Botanical Garden staff.

235-238—Plant Distribution. Problems dealing with regional botany or plant geography. Professor BRITTON and other members of the staff.

239-240—Developmental Taxonomy. Fossil ancestors of some family of plants. Dr. HOLLICK.

241-242—Research on the Physiology of the Cell and Reproduction. Professor HARPER.

243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. Dr. STOUT.

301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. Professor HARPER.

CONVENTION—A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

51-52—Principles of Plant Morphology and Physiology. C 2 hours, L 4 hours. Professor RICHARDS, Misses LATHAM and — (Barnard).

53-54—General Morphology and Development of Plants. C 2 hours, L 4 hours. Professor HAZEN and Miss — (Barnard).

55-56—Morphology and Classification of Spermatophytes. Study of the Natural Orders. C 1 hour, L 4 or 6 hours. Professor HAZEN.

153—Anatomy of Vascular Plants. C 2 hours and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM (Barnard). Full course.

154—Physiology of Plants from Standpoint of Nutrition. C 2 hours and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM (Barnard). Full course.

[156—Physiology of Plants from Standpoint of Growth. C 2 hours and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM (Barnard). Full course.]

158—Structure and Development of Algæ. Advanced course. C 1 hour, L 8 hours. Professor HAZEN. Full course.

159—Structure and Development of Fungi. Advanced course. C 1 hour, L 8 hours. Professor RICHARDS. Full course.

Courses 158-59 are not usually given the same year.

160—Embryology and Laboratory Methods. Practice in methods of technique, with the study of the embryology of one or more types. L 8 hours with occasional lectures and outside reading. Professor HAZEN. Full course.

161, 162—Advanced Physiology and Morphology. Work will be arranged to suit the needs of the students. Professors RICHARDS and HAZEN and Miss LATHAM (Barnard). Half, full or double course.

Summer Session and Extension Teaching

(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain prerequisite courses in subject-matter education, are given in the Department of Biology of Teachers College by Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in Teachers College Announcement.

Courses in Biometrical Methods

See page 26

PATHOLOGY

101-102—General and Special Pathology. 3 hours, first half, and 9 hours. Professors MACCALLUM and JOBLING and Drs. PAPPENHEIMER, LAMBERT, HARVEY and others. Two full courses.

105-106—Gross Pathological Anatomy and Attendance Upon Autopsies. 2 hours and at other times as occasion offers. Professors MACCALLUM, JOBLING and LARKIN and Drs. FIELD, LAMB and others.

107—Experimental Pathology. 3 hours; limited to twelve students. Professor MACCALLUM. Half course.

201-202—Advanced Pathology. The officers of the department.

251-252—Research in Pathology. Under the direction of the professor of Pathology. The officers of the department.

PHYSIOLOGY

106-107—Human Physiology. Lectures 3 hours; demonstrations 1 hour; recitations 2 hours; laboratory work 3 hours. Professor BURTON-OPITZ and Drs. GORDON, PARDEE, SHEARER, TARRIBERRY and WILLIAMS. Two full courses.

201-202—General Physiology. Lectures 1 hour; laboratory work 5 hours. Professors LEE and PIKE and Mr. SCOTT. Two full courses.

203-204—Special Physiology. Lectures 1 hour; laboratory work 5 hours. Professors BURTON-OPITZ and PIKE and Dr. WILLIAMS. Two full courses.

205-206—Problems of Evolution from the Standpoint of Physiology. Lectures 1 hour. Professor PIKE. Half course.

251-252—Research in Physiology. Under the direction of the professor of Physiology. The officers of the department.

Journal Club

A journal club, composed of the members of the staff and graduate students, holds weekly meetings for the discussion of current literature and special investigations.

Columbia College

101-102—Elementary Physiology. C 1 hour, L 2 hours. 619 S. Professor PIKE and Mr. SCOTT.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, pp. 19 and 20. They include Courses Nos. **101** and **102**, General Plant Physiology (Professor Marquette); **120**, Plant Reactions (Professor Marquette); **201-208**, Advanced Physiology (Professors Richards, Curtis and Marquette); Physiology of Nutrition (Professors Richards and Gies).

Barnard College

A course in general Animal Physiology is given by the Department of Zoölogy of Barnard College, supplementing the work in general Biology and Zoölogy. (See p. 26.) Professor OSBURN and Dr. L. H. GREGORY.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College (see p. 21): One dealing with Plant Nutrition, Botany **154**, a second with Growth, Botany **156**, a third with advanced problems in physiology, Botany **161-162**. Professor RICHARDS and Miss LATHAM.

Summer Session

(See separately printed announcement)

Courses in Teachers College

The courses in Applied Biology given in Teachers College are chiefly physiological. Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See Teachers College Announcement.

THERAPEUTICS

(Pharmacology)

211-212—Psychopathology and Psychotherapy, inclusive of the Pathology, Psychotherapy and Mental Examinations of the Psychopathic Child. At the Vanderbilt Clinic; clinical lectures; 2 hours for one-half year. Dr. HABERMAN.

213-214—General Pharmacology. Lectures, 1 hour; laboratory work, 6 hours. Professor LIEB and Dr FREEMAN. Two full courses.

215—Biological Standardization of Drugs. Laboratory work 7 hours; first half-year. Professor LIEB. Half course.

ZOOLOGY

Graduate major work in zoölogy requires at least two years of preparatory undergraduate study or the equivalent, *i.e.*, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses 1-4, 91-92 and 94. For minor or special work a less extensive preparation may suffice, but all candidates for minor work must have taken at least one year's work in zoölogy or elementary biology. Of the following courses, 1-2, 3-4, 5, 6, 7-8, 53-54, 91-92 and 94 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a sufficient standard of knowledge and training as shown by the master's thesis or the doctor's dissertation. The amount of time required by the graduate courses is indicated by designating them as full courses, double courses and half courses, which require respectively the approximate equivalent in total time of one day, two days, or a half day during one semester. The course requirements for the Ph.D. degree are approximately double those for the M.A. degree (eight full courses); in either case specially assigned study or research (to be registered as Course 227-228) may in part take the place of formal course-work. Courses 201 and 223-224 are recommended to all Ph.D. major students as a general foundation. Students who have not taken 91-92 as undergraduates may take 101-102 (counting as two full courses) as part of their minor work; but these courses will not be accepted as part of the major work for either degree.

All of the graduate Courses are open to women.

1-2—Elementary Biology (Zoölogy). C 2 hours, L 4 hours. Professors CALKINS and MCGREGOR (Columbia College); Professors CRAMPTON and OSBURN, Miss DEDERER, Dr. L. H. GREGORY (Barnard College).

3—Elementary Histology. 1 hour. Professor MCGREGOR (Columbia College); Miss DEDERER (Barnard College).

4—Elementary Embryology. C 1 hour, L 2 hours. Professor MORGAN (Columbia College); Professor OSBURN (Barnard College).

5—General Biology. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

Prerequisite: Course 1-2.

6—Experimental Biology. An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

7-8—Biology and Vital Relations of the Human Organism. General anatomy and physiology of the human type in comparison with other organisms; the biological basis of individual hygiene; human genetics or social relations. Professor CRAMPTON and Dr. GREGORY. 4 points. (Barnard College.)

W. and F. at 3.

Open to students of all classes. Students who have previously taken Course 1-2 will receive only 2 points credit. This course does not count as fulfilling the prescribed requirement in science for the A.B. or B.S. degree.

53-54—Practical Zoölogy and Embryology. 2 points. Miss DEDERER (Barnard College).

91-92—General Zoölogy. C 2 hours, L 6 hours. Professor MCGREGOR (Columbia College).

94—Embryology of Vertebrates. C 1 hour, L 2 hours. Professor MCGREGOR (Columbia College).

101-102—General Zoölogy. This course covers the same general ground as 91-92, but is supplemented by additional assigned work. It may not be counted as part of the major work toward the higher degrees. Professor MCGREGOR (Columbia College); Professors CRAMPTON and OSBURN, Miss DEDERER, Dr. L. H. GREGORY (Barnard College). 2 full courses.

110—The Parasitic Protozoa. A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had Zoölogy 91 or its equivalent. Professor CALKINS. Full course.

113—Tropisms. This course deals with the simpler responses of organisms to external factors and serves as an introduction to the next course, 114. One lecture a week. Professor MORGAN. Full course.

Prerequisite: 1-2, 91-92.

114—Instincts. An analysis of the more complex behavior of animals, and the problems of the evolution of instincts. One lecture a week. Professor MORGAN. Full course.

Prerequisite: 1-2, 91-92.

151-152—General Physiology. General principles of human and animal physiology. C 2 hours, L 4 hours. Professor OSBURN, Dr. L. H. GREGORY (Barnard College). 2 full courses.

A. Advanced General Zoölogy

The two following courses are designed to complete the work in general zoölogy begun in 1-2 and continued in 91-92, and are recommended to all students making zoölogy their major subject. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

201—Topics in Invertebrate Zoölogy, with Especial Reference to Problems of Phylogeny. 2 days a week. Professor WILSON. Double course.

223-224—Evolution of the Vertebrates. Structure, origin and phylogeny of the principal groups, living and extinct, from the proto-chordates upward. Adaptation as a key to morphology. Principles of phylogeny. Evolution of the vertebrate skeleton. Study of recent and fossil material at the American Museum. 10 hours, lectures and laboratory. Dr. W. K. GREGORY. 2 full courses.

B. Embryology and Cellular Biology

208-209—Comparative Embryology (see also 4 and 94). Facts and principles of animal development.

208—General Embryology of Invertebrate Types. Lectures, special reading, and laboratory work. 1 day a week. Professor CALKINS. Full course.

209—Embryology (with special reference to comparative organogeny) of the main Vertebrate types. Lectures, demonstrations and reading, 1 day a week. Professor DEAN. Full course.

220—Cellular Embryology (see also 218 and 225-6). A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. One lecture a week and assigned work. Courses 94 and 208-209 form a desirable preparation. This and 218 are parallel courses which supplement each other. Professor WILSON. Full course.

225-226—Cellular Biology. General structure and functions of the cell. Professor WILSON. 2 full courses.

C. Morphology and Evolution of Special Groups

203-204—Mammals, Living and Fossil. Structure, origin and phylogeny of the principal groups. Adaptation as a key to morphology. Parallel and convergent evolution. Study of recent and fossil material at the American Museum. 10 hours, lecture and laboratory. Dr. W. K. GREGORY. 2 full courses.

206—Fishes, Living and Fossil. This course considers especially the phylogenetic relations of the sub-classes and orders of fishes. Professor DEAN. Full course.

D. Protozoölogy

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life history, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

221-222—Protozoölogy. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology and physiology. Professor CALKINS. 2 full courses.

See also 110—Parasitic Protozoa.

E. Experimental Zoölogy

The following four courses (215-218 and 113-114) cover three years of one day a week. Each course may be taken independently of the others and not necessarily in the order given.

215-216—Experimental Zoölogy. This course includes a treatment of such questions as the influence of external conditions in modifying species and in affecting modes of reproduction; Mendelian heredity; the determination of sex. One lecture a week, with laboratory work on special problems. Professor MORGAN. 2 full courses.

217—Experimental Study of Regeneration. The phenomena of regeneration are studied as bearing on the problem of growth. A principal feature of this course is the formulation of special problems for further investigation. 1 day a week. Professor MORGAN. Full course.

218—Experimental Embryology. The rôle of external factors in normal development. This course is parallel to 220, which treats of internal factors. One lecture a week. Professor MORGAN. Half course.

227-228—Special Research. Investigation of special problems in any of the subjects enumerated above, counting as half, full, or double course.

Course in the College of Physicians and Surgeons

101—Histology and Embryology. 12 hours. Professors SCHULTE and MILLER and Drs. STRONG and SHARP. Double course.

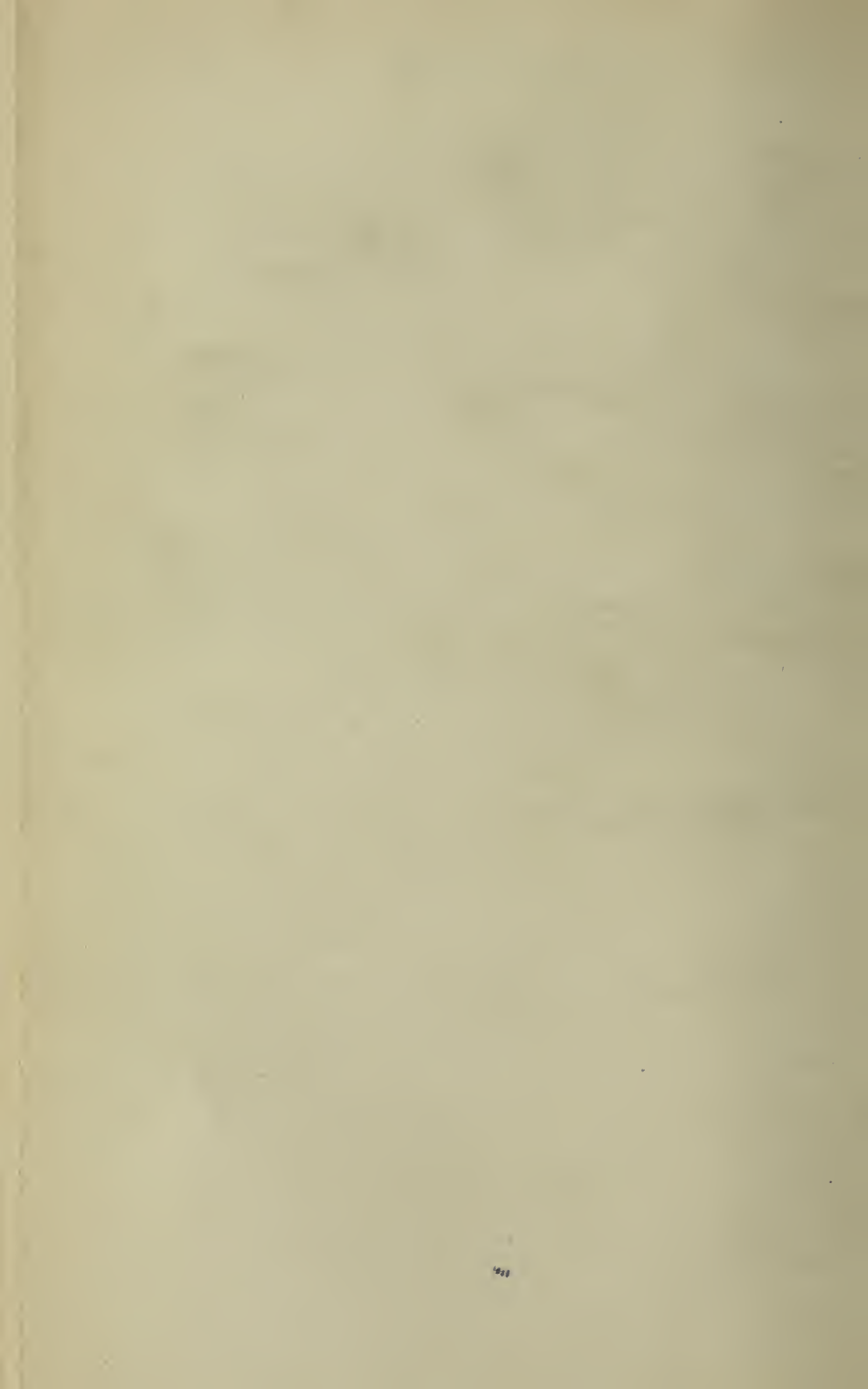
Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See **Biology** and **Nature-Study** in Teachers College Announcement.

Courses in Biometrical Methods

Anthropology 121—Anthropometry-Biometrical Methods. This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the inter-relations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged. C 2 hours. Professor BoAS.

Anthropology 122—Anthropometry-Growth. A discussion of the phenomena of growth with special relation to the influences of heredity and of environment. C 2 hours. Professor BoAS.



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1914/15

Fourteenth Series, No. 23

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June 27, 1914



Columbia University Bulletin of Information

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DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PATHOLOGY, PHARMA-
COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1914-1915

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(Issued 25 times during the Academic year, monthly in November and December, and weekly between February and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under the Act of July 16, 1894.)

These include:

1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, issued in December, price 25 cents.
3. The Announcements of the several Colleges, and Schools and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University. For information as to the various courses offered by the University consult the last page of this Announcement.

ABRIDGED ACADEMIC CALENDAR

The Academic year is thirty-seven weeks in length, ending on the second Wednesday in June. In 1914-15 the year begins on September 23, 1914, and ends on June 9, 1915. It is divided into two half-years. In 1914-15 the second half-year begins on February 3, 1915. The Summer Session for 1914 begins on July 6 and ends on August 14.

The exercises of the University are suspended on Election Day, Thanksgiving Day, and the following two days, for two weeks at Christmas, on Washington's Birthday, from the Thursday before Good Friday through the following Monday, and on Memorial Day.

The complete Academic Calendar will be found in the University Catalogue, and so far as it refers to the students studying under any Faculty, in the Announcement of that Faculty.

OFFICERS OF THE DIVISION OF BIOLOGY

- GEORGE S. HUNTINGTON.....*Professor of Anatomy, Executive officer,
Department of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D.,
Jefferson Medical College, 1907.
- HENRY FAIRFIELD OSBORN.....*Research Professor of Zoölogy*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901; Prince-
ton, 1902; Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.) Chris-
tiana, 1911; Member of National Academy of Sciences.
- EDMUND B. WILSON.....*Da Costa Professor of Zoölogy, Executive
officer, Department of Zoölogy*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902;
LL.D., Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.), Leipsic, 1909;
Member of National Academy of Sciences.
- FREDERIC S. LEE.....*Dalton Professor of Physiology, Executive
officer, Department of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN.....*Professor of Vertebrate Zoölogy*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D.,
1890; Chevalier de la Légion d'Honneur, 1910.
- HENRY E. CRAMPTON.....*Professor of Zoölogy*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES.....*Professor of Biological Chemistry, Executive
officer, Department of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS....*Professor of Botany and Secretary of the
Division*
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS.....*Professor of Protozoölogy*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.
- MAURICE A. BIGELOW.....*Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- RUSSELL BURTON-OPITZ.....*Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN.....*Professor of Experimental Zoölogy*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; Member
of National Academy of Sciences.
- BERN B. GALLAUDET.....*Assistant Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.
- JOHN HENRY LARKIN.....*Assistant Professor of Pathology*
A.B., Manhattan, 1891; M.D., Columbia, 1894.
- JAMES HOWARD MCGREGOR.....*Associate Professor of Zoölogy*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.

- HERMANN VON W. SCHULTE.....*Associate Professor of Anatomy*
A.B., Trinity, 1897; M.D., Columbia, 1902.
- CARLTON CLARENCE CURTIS.....*Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.
- WILLIAM G. MACCALLUM.....*Professor of Pathology, Executive*
officer, Department of Pathology
A.B., Toronto, 1894; M.D., Johns Hopkins, 1897.
- TRACY E. HAZEN.....*Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- RAYMOND C. OSBURN.....*Assistant Professor of Zoölogy*
B.S., Ohio State, 1898; M.S., 1900; Ph.D., Columbia, 1906.
- ROBERT A. HARPER.....*Torrey Professor of Botany, Executive officer,*
Department of Botany
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences.
- WILLIAM G. MARQUETTE.....*Associate Professor of Botany*
Ph.G., Northwestern, 1899; B.S., Wisconsin, 1903; Ph.D., 1907
- FRANK HENRY PIKE.....*Assistant Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- PAUL E. HOWE.....*Assistant Professor of Biological Chemistry*
B.S., Illinois, 1906; A.M., 1907; Ph.D., 1910.
- CHARLES C. LIEB.....*Assistant Professor of Pharmacology, Executive*
officer, Department of Pharmacology
A.B., Columbia, 1902; M.D., 1906.
- ADAM M. MILLER.....*Assistant Professor of Anatomy*
A.B., Princeton, 1901; A.M., 1902.
- JAMES W. JOBLING.....*Assistant Professor of Pathology*
M.D., Tennessee Medical College, 1897.
- HANS ZINSSER.....*Professor of Bacteriology, Executive*
officer, Department of Bacteriology
A.B., Columbia, 1899; A.M. and M.D., 1903.
- JEAN BROADHURST...*Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908.
- WALTER A. BASTEDO.....*Associate in Pharmacology and Therapeutics*
Ph.G., New York College of Pharmacy, 1894; M.D., Columbia, 1899.
- ALWIN M. PAPPENHEIMER.....*Associate in Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY.....*Associate in Anatomy*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- WALTER H. EDDY.....*Associate in Biological Chemistry*
B.S., Amherst, 1898; A.M., Columbia, 1908; Ph.D., 1909.
- HAVEN EMERSON.....*Associate in Physiology*
A.B., Harvard, 1896; A.M. and M.D., Columbia, 1899.

- HORATIO B. WILLIAMS.....*Associate in Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- ALFRED P. LOTHROP.....*Associate in Biological Chemistry*
A.B., Oberlin, 1906; A.M., 1907; Ph.D., Columbia, 1909.
- ROBERT A. LAMBERT.....*Associate in Pathology*
M.D., Tulane, 1907.
- WILLIAM K. GREGORY.....*Associate in Zoölogy*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- HERMAN O. MOSENTHAL.....*Associate in Biological Chemistry*
A.B., Columbia, 1899; M.D., 1903.
- J. GARDNER HOPKINS.....*Associate in Bacteriology*
A.B., Columbia, 1902; M.D., Johns Hopkins, 1907.
- OLIVER S. STRONG.....*Instructor in Anatomy*
A.B., Princeton, 1886; A.M., Columbia, 1892; Ph.D., 1896.
- J. VICTOR HABERMAN.....*Instructor in Neurology and in Psycho-
Therapeutics*
A.B., Columbia, 1903; M.D., 1905.
- PAULINE H. DEDERER.....*Instructor in Zoölogy in Barnard College*
A.B., Columbia, 1901; A.M., 1907.
- MARION E. LATHAM.....*Instructor in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- LOUISE H. GREGORY.....*Instructor in Zoölogy in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- LEANDER H. SHEARER.....*Instructor in Physiology*
A.B., Princeton, 1897; M.D., Columbia, 1901.
- FREDERICK B. HUMPHREYS.....*Instructor in Pathology*
Ph.B., Yale, 1899; M.D., Columbia, 1903.
- JAMES G. DWYER.....*Instructor in Bacteriology*
M.D., Queen's, 1905.
- WILLIAM K. TERRIBERRY.....*Instructor in Physiology*
A.B., Yale, 1903; M.D., Columbia, 1907.
- DONALD GORDON.....*Instructor in Physiology*
M.D., Columbia, 1906.
- ALFRED J. BROWN.....*Instructor in Anatomy*
A.B., Yale, 1899; M.D., Columbia, 1903.
- RICHARD DERBY.....*Instructor in Anatomy*
A.B., Harvard, 1903; M.D., Columbia, 1907.
- JOHN C. VAUGHAN.....*Instructor in Anatomy*
M.D., Columbia, 1907.
- ERNEST L. SCOTT.....*Instructor in Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911.

- JAMES CLAYTON SHARP.....*Instructor in Anatomy*
M.D., Columbia, 1901.
- FORDYCE B. ST. JOHN.....*Instructor in Anatomy*
B.S., Princeton, 1905; M.D., Columbia, 1909.
- BERNARD O. DODGE.....*Instructor in Botany*
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- FREDERIC G. GOODRIDGE.....*Instructor in Biological Chemistry*
A.B., Harvard, 1897; M.D., Columbia, 1901.
- ANTHONY C. FREEMAN.....*Instructor in Pharmacology*
A.B., Stanford University, 1906; M.D., Columbia, 1910.
- GEORGE M. GOODWIN.....*Instructor in Pharmacology*
- SERGIUS MORGULIS.....*Instructor in Biological Chemistry*
Ph.D., Harvard, 1910.
- REUBEN OTTENBERG.....*Instructor in Bacteriology*
A.B., Columbia, 1902; M.D., 1905.
- HAROLD E. B. PARDEE.....*Instructor in Physiology*
A.B., Columbia, 1906; M.D., 1909.
- MAURICE J. SITTENFIELD.....*Instructor in Pathology*
M.D., Bellevue Hospital Medical College, 1898.
- GEORGE R. DEMPSEY.....*Instructor in Pathology*
M.D., Cornell, 1911.
- CAROLINE STACKPOLE.....*Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- EMILY C. SEAMAN.....*Instructor in Household Arts in Teachers College*
B.S., Adelphi, 1899; A.M., Columbia, 1905; Ph.D., 1912.
- CHARLES PACKARD.....*Assistant in Zoölogy*
B.S., Syracuse, 1907; M.S., 1908.
- EDGAR ALTENBURG.....*Assistant in Botany*
A.B., Columbia, 1911; A.M., 1912.
- ALBERT R. LAMB.....*Assistant in Pathology*
A.B., Yale, 1903; M.D., Columbia, 1907.
- HUBERT B. GOODRICH.....*Assistant in Zoölogy*
B.S., Amherst, 1909.
- ARTHUR KNUDSON.....*Assistant in Biological Chemistry*
A.B., Missouri, 1912.
- OTTO KUNKEL.....*Research Assistant in Botany*
B.S., Missouri, 1909; A.B., 1910; A.M., 1911.
- HERMANN J. MULLER.....*Assistant in Zoölogy*
A.B., Columbia, 1910; A.M., 1911.
- CALVIN B. COULTER.....*Assistant in Pathology*
A.B., Williams, 1907; A.M., Princeton, 1908; M.D., Columbia, 1913.
- CYRUS W. FIELD.....*Assistant in Pathology*

- ALLEN C. FRASER.....*Assistant in Botany*
B.S., Cornell.
- WILLIAM A. PERLZWEIG.....*Assistant in Biological Chemistry*
A.B., Columbia, 1913.
- FREDERICK V. RAND.....*Assistant in Botany*
B.S., Vermont, 1908; M.S., 1911.
- MARY W. STEWART.....*Assistant in Botany in Barnard College*
A.B., Columbia, 1913.
- ERNEST C. STILLMAN.....*Assistant in Pathology*
A.B., Harvard, 1907; M.D., Columbia, 1913.
- VICTOR E. LEVINE.....*Assistant in Biological Chemistry*
A.B., C. C. N. Y., 1909; A.M., Columbia, 1911.
- CHARLES WEISMAN.....*Assistant in Biological Chemistry*
B.S., College of the City of New York, 1900; M.S., 1902; Ph.D., Columbia, 1913.

Members of the Staff of the Botanical Garden Giving Instruction in the Division

- NATHANIEL LORD BRITTON, Ph.D., Sc.D.....*Director*
- WILLIAM ALPHONSO MURRILL, Ph.D.....*Assistant Director*
- ARLOW BURDETTE STOUT, Ph.D.....*Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D.....*Head Curator of the Museums*
- FRED. JAY SEAVER, Ph.D.....*Curator*
- PER AXEL RYBERG, Ph.D.....*Curator*
- ARTHUR HOLLICK, Ph.D.....*Curator*
- MARSHALL AVERY HOWE, Ph.D.....*Curator*
- GEORGE VALENTINE NASH.....*Curator of the Plantations*
- HENRY HURD RUSBY, M.D.....*Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D.....*Consulting Chemist*

Partial courses are also given by

- ELIZABETH GERTRUDE BRITTON EDWARD SANFORD BURGESS, Ph.D.

GENERAL STATEMENT

Introductory

The Division of Biology includes the departments of Anatomy, Bacteriology, Biological Chemistry (Nutrition), Botany, Pathology, Physiology, Pharmacology, and Zoölogy in all schools of the University.

Students in this Division are received as candidates for the degrees of Master of Arts and Doctor of Philosophy under the Faculty of Pure Science. Certain courses which may be counted toward a higher degree are also offered in the Summer Session and in Extension Teaching.

Degrees

The requirements for the higher degrees are stated in full in a bulletin entitled "Instruction for Candidates for the Degrees of Master of Arts and Doctor of Philosophy," which will be sent upon application to the Secretary of the University. This bulletin contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments and all other University matters of interest to graduate students.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those for men.

Funds and Prizes

Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy

The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material,

both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology

The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media and for the chemical study of bacterial products. The laboratories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

BIOLOGICAL CHEMISTRY

(Nutrition)

At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor Gies' library occupies a room adjoining the laboratory and is accessible by appointment to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoölogical Park for research, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany

The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultraviolet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to

physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammeters, resistance measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus afford facilities for experimental work in physiology and pathology and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic collections are in special rooms. Ample opportunity for experimental work in plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses.

The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

A seminar for the study of special subjects in general physiology meets weekly and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a bi-weekly colloquium.

Pathology

The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, amphitheater, photographic rooms, etc., on the fifth floor. On the fourth floor there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a clinical laboratory, the museum, preparation rooms,

cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology

The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises one large laboratory, which is provided with special apparatus for teaching purposes; one large and four small laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, mainly for research; a library containing sets of the physiological journals, monographs and other books, and many reprints of special articles; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoölogy

The zoölogical laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoölogy, and eight rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the collections of the American Museum of Natural History (see below), the department does not maintain a general zoölogical museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, chart and wax models and an aquarium room in which a variety of living animals and plants are kept.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoölogy and palæontology of invertebrates and vertebrates, both from the systematic and bionomic point of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoölogical Park in the Borough of the Bronx, under the direction of the New York Zoölogical Society, affords exceptional opportunities for the study of living reptiles, birds and mammals.

The New York Aquarium, also under the management of the Zoölogical Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets every week in the departmental library to report upon special investigations and to present abstracts of articles of special importance in the biological journals. A weekly seminar open to all members of the department is also carried on, for the more thorough discussion of some selected topic of general interest.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former three investigators' rooms are subscribed for by the University for the use of the Department of Zoölogy; in the latter a table is available through the John D. Jones Scholarship. The University also maintains an investigators' table at the Naples Zoölogical Station. In addition to the above facilities, field expeditions are from time to time sent out by the department.

Publications by Members of the Division

The University Press issues the *Columbia University Biological Series*, of which ten volumes have already appeared.

ANATOMY

101—Histology and Embryology. Lectures, conferences and laboratory work 12 hours; first half-year. Professors SCHULTE and MILLER and Drs. STRONG and SHARP. Double course.

103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences and dissections 12 hours. Drs. BROWN and VAUGHAN. Two full courses.

105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work and dissection 12 hours; first half-year. Drs. TILNEY, STRONG and ST. JOHN. Double course.

107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations 3 hours; first half-year. Professor HUNTINGTON. Half course.

202—Special Morphology. 3 hours; second half-year. Professors HUNTINGTON, SCHULTE and MILLER. Half course.

204—Morphology of the Nervous System. 3 hours; second half-year. Professor TILNEY. Half course.

251-252—Research in Anatomy. Under the direction of the professor of anatomy. The officers of the department. Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

302—Seminar in Histology and Embryology. 1 hour; second half-year. Professor SCHULTE.

BACTERIOLOGY

Preliminary Statement

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoölogy in the Department of Zoölogy.

Courses 201 and 203 are open to women.

101—General Bacteriology, especially adapted to the requirements of students of medicine. 6 hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. Professor ZINSSER and Drs. HOPKINS, DWYER and Mr. BLISS. Full course.

201—Advanced Bacteriology. This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides.

Text-books: Hiss and Zinsser's Text-book of Bacteriology, Kolle u. Wassermann's Handbuch d. Pathogenen Mikroorganismen, Macé's Bacteriologie.

The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon in October, November, December and January. Professor ZINSSER, Dr. HOPKINS and Dr. DWYER. Double course.

203—Special Bacteriology. As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; practical work in photomicrography, and the pursuit of some selected theme for original investigation. Professor ZINSSER. Rating individually determined for each case at the time of registration.

Text-books: Hiss and Zinsser's Text-book of Bacteriology, Kolle u. Wassermann's Handbuch der Pathogenen Mikroorganismen.

Attendance and hours as in Course 201, with additional time for research.

205-206—The Principles of Infection, Immunity, Serum Diagnosis and Therapy. Lectures with demonstrations 1 hour. Professor ZINSSER. Half course.

208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twelve students. Professor ZINSSER, Dr. HOPKINS, Dr. OTTENBERG. Full course.

251-252—Research in Bacteriology. Under the direction of the professor of bacteriology. The officers of the department. Rating individually determined at the time of registration.

Summer Session

SI01—General Bacteriology. 2 points, equivalent to Course 101. Dr. HOPKINS and Dr. DWYER. Full course.

Course in Teachers College

A course in bacteriology applied to household arts is given in Teachers College by Miss Broadhurst.

Course in the College of Pharmacy

A laboratory course of 32 hours in Bacteriology is given in the College of Pharmacy.

BIOLOGICAL CHEMISTRY

(Nutrition)

Courses in Nutrition (Physiological and Pathological Chemistry)

101 or 102—General Physiological Chemistry. A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes. 8 hours. Full course.

Required, in the second half of the first year, of candidates for M.D. Open as an elective to qualified Juniors and Seniors of Columbia College. Professors GIES and HOWE, Dr. LOTHROP and Messrs. KNUDSON and PERLZWEIG.

201-202—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Household Arts.) C 1 hour, L 5 hours. Professor GIES and Dr. SEAMAN. Full course.

211-212—Biochemical Methods of Research, including Clinical Methods. C 1 hour, L 7 hours. Professors GIES and HOWE and Messrs. KNUDSON and PERLZWEIG. Two full courses.

225-226—Nutrition in Disease. C 2 hours. Professors GIES and HOWE and Drs. MOSENTHAL, GOODRIDGE and WEINBERGER. Half course.

221-222—Nutrition in Health (advanced physiological chemistry). C 2 hours, L 18 hours. Professors GIES and HOWE and Dr. MORGULIS. Double course.

223-224—Nutrition in Disease (general pathological chemistry). C 2 hours, L 18 hours. Professor GIES. Double course.

251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 20 hours. Professors GIES and HOWE. Double course.

Toxicological Chemistry

261-262—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L 10 hours. Professor GIES. Two full courses.

Botanical Chemistry

271-272—Chemical Physiology of Plants. C 1 hour, L 7 hours. Professor GIES. Two full courses. (The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is consulting chemist.) See Botany, page 16.

Bacteriological Chemistry

281-282—Chemistry of Micro-organisms; Fermentations, Putrefactions, and Enzyme Actions in General (introduction to sanitary chemistry). C 1 hour, L 7 hours. Professor GIES. Two full courses.

Seminar

301-302—The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department meet weekly to discuss results of recent researches in chemical biology. 1 hour. Professor GIES.

Course in the College of Pharmacy

A course of 30 lectures in Biological Chemistry is given in the College of Pharmacy.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University. It also issues the quarterly BIOCHEMICAL BULLETIN.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering upon major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4 and 101-102 for men or Courses 51-52, 53-54,

153 and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major requirement must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

Minor work in botany presupposes two years' preparation in the subject, with at least four full courses for the degree of Doctor of Philosophy or two full courses for the degree of Master of Arts.

All graduate courses are open to women.

1-2—General Botany. C 2 and L 4 hours. Professor CURTIS and Dr. DODGE.

3-4—Plant Morphology. C 2 and L 4 hours. Professors HARPER and CURTIS.

5—Elementary Plant Pathology. C 1, L 3 hours. Dr. DODGE.

6—Economic Botany. C 1 hour, L 3 hours. Dr. DODGE.

7—Growth and Character of Timber. C 1 hour, L 3 hours. Professor CURTIS and Mr. ALTENBURG.

9-10—Botanical Problems. Introductory to research. Professors HARPER, CURTIS and MARQUETTE.

11-12—Plant Anatomy and Histology. C 2, L 4 hours. Professor MARQUETTE.

101-102—Plant Physiology. C 2 hours, L 6 hours. Professor MARQUETTE. Two full courses.

103-104—Structure and Development of Plants. A general survey of the plant kingdom from the standpoint of structure and phylogeny. Professors HARPER and CURTIS. Two full courses.

113-114—Morphology of the Higher Plants. Study of the orders, including the structure and relationship of plants. Professor CURTIS, Mr. RAND. Two full courses.

115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. Professor HARPER. Two full courses.

117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. Professor HARPER. Two full courses.

120—Plant Reactions. Lectures and demonstrations on the responses of plants to external stimuli. Professor MARQUETTE. Half-course.

201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. Professors RICHARDS, CURTIS and MARQUETTE. Two full courses.

209-210—Physiology of Nutrition—treated from a chemical standpoint. Professors RICHARDS and GIES. Two full courses.

211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. Professor HARPER, Dr. MURRILL and Dr. SEAVER. Two full courses.

217-218—Embryology of Spermatophyta. With special work during two summers. Professors CURTIS and HAZEN. Two full courses.

219-220—Morphology. Work dealing with morphological problems in the various groups of plants. Directed by members of the department and Botanical Garden staff. Two full courses.

222-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. Directed by members of the Botanical Garden staff. Two full courses.

235-236—Plant Distribution. Problems dealing with regional botany or plant geography. Professor BRITTON and other members of the staff. Two full courses.

239-240—Developmental Taxonomy. Fossil ancestors of some family of plants. Dr. HOLLICK. Two full courses.

241-242—Research on the Physiology of the Cell and Reproduction. Professor HARPER. Two full courses.

243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. Dr. STOUT. Two full courses.

301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. Professor HARPER. Two full courses.

COLLOQUIUM—A biweekly meeting for the discussion of current botanical literature.

CONVENTION—A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

51-52—**Principles of Plant Morphology and Physiology.** C 2 hours, L 4 hours. Professor RICHARDS, Misses LATHAM and STEWART (Barnard).

53-54—**General Morphology and Development of Plants.** C 2 hours, L 4 hours. Professor HAZEN and Miss STEWART (Barnard).

55-56—**Morphology and Classification of Spermatophytes.** Study of the Natural Orders. C 1 hour, L 4 or 6 hours. Professor HAZEN.

153—**Anatomy of Vascular Plants.** C 2 hours and a minimum of L 6 hours. Miss LATHAM (Barnard). Full course.

[154—**Physiology of Plants from Standpoint of Nutrition.** C 2 hours and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM (Barnard). Full course. Not given, 1914-15.]

156—**Physiology of Plants from Standpoint of Growth.** C 2 hours and a minimum of L 6 hours. Professor RICHARDS and Miss LATHAM (Barnard). Full course.

158—**Structure and Development of Algæ.** Advanced course. C 1 hour, L 8 hours. Professor HAZEN. Full course.

159—**Structure and Development of Fungi.** Advanced course. C 1 hour, L 8 hours. Professor RICHARDS. Full course.

Courses 158-59 are not usually given the same year.

160—**Embryology and Laboratory Methods.** Practice in methods of technique, with the study of the embryology of one or more types. L 8 hours with occasional lectures and outside reading. Professor HAZEN. Full course.

161-162—**Advanced Physiology and Morphology.** Work will be arranged to suit the needs of the students. Professors RICHARDS and HAZEN and Miss LATHAM (Barnard). Half, full or double course.

Summer Session and Extension Teaching

(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain prerequisite courses in subject-matter education, are given in the Department of Biology of Teachers College by Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in Teachers College Announcement.

Courses in the College of Pharmacy

A course of 30 lectures, 30 recitation hours and 75 hours laboratory work in structural and descriptive botany; a laboratory course of

90 hours in botany applied to the study of drugs; and a course of 30 hours in plant classification are given in the College of Pharmacy.

Courses in Biometrical Methods

See page 27

PATHOLOGY

101-102—General and Special Pathology. 3 hours, first half, and 9 hours. Professors MACCALLUM and JOBLING and Drs. PAPPENHEIMER, LAMBERT, and others. Two full courses.

105-106—Gross Pathological Anatomy and Attendance Upon Autopsies. 2 hours and at other times as occasion offers. Professors MACCALLUM, JOBLING and Drs. FIELD, LAMB, PAPPENHEIMER and others. One full course.

107—Experimental Pathology. 3 hours; limited to twelve students. Professor MACCALLUM. Half course.

201-202—Advanced Pathology. The officers of the department. One full course.

251-252—Research in Pathology. Under the direction of the professor of Pathology. The officers of the department. Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

See also additional courses listed under George Crocker Special Research Fund on page 26.

PHYSIOLOGY

106-107—Human Physiology. Lectures 3 hours; demonstrations 1 hour; recitations 2 hours; laboratory work 3 hours. Professor BURTON-OPITZ and Drs. GORDON, PARDEE, SHEARER, TERRIBERRY and WILLIAMS. Two full courses.

201-202—General Physiology. Lectures 1 hour; laboratory work 5 hours. Professors LEE and PIKE and Dr. SCOTT. Two full courses.

203-204—Special Physiology. Lectures 1 hour; laboratory work 5 hours. Professors BURTON-OPITZ and PIKE and Dr. WILLIAMS. Two full courses.

205-206—Problems of Evolution from the Standpoint of Physiology. Lectures 1 hour. Professor PIKE. Half course.

251-252—Research in Physiology. Under the direction of the professor of Physiology. The officers of the department. Hours to be

arranged. Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

Course in Columbia College

1-2—Elementary Physiology. C 1 hour, L 2 hours. 619 S. Professor PIKE and Dr. SCOTT. 3 points.

Courses in Barnard College

A course in general Animal Physiology is given by the Department of Zoölogy of Barnard College, supplementing the work in general Biology and Zoölogy. (See p. 26.) Professor OSBURN and Dr. L. H. GREGORY.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College (see p. 21): One dealing with Plant Nutrition, Botany 154, a second with Growth, Botany 156, a third with advanced problems in physiology, Botany 161-162. Professor RICHARDS and Miss LATHAM.

Summer Session

(See separately printed announcement)

Courses in Teachers College

The courses in Applied Biology given in Teachers College are chiefly physiological. Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See Teachers College Announcement.

Course in the College of Pharmacy

A course of 30 lectures and 30 recitations in Human Physiology is given in the College of Pharmacy.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, pp. 19 and 20. They include Courses Nos. 101 and 102, General Plant Physiology (Professor Marquette); 120, Plant Reactions (Professor Marquette); 201-208, Advanced Physiology (Professors Richards, Curtis and Marquette); Physiology of Nutrition (Professors Richards and Gies).

Journal Club

A journal club, composed of the members of the staff and graduate students, holds weekly meetings for the discussion of current literature and special investigations.

THERAPEUTICS

(Pharmacology)

211-212—Psychopathology and Psychotherapy, inclusive of the Pathology, Psychotherapy and Mental Examinations of the Psycho-

pathic Child. At the Vanderbilt Clinic; clinical lectures; one hour for one-half year. Dr. HABERMAN. Half course. This course may be elected for either the first or the second half year.

213-214—General Pharmacology. Lectures, 1 hour; laboratory work, 6 hours. Professor LIEB and Dr. FREEMAN. Two full courses.

215—Biological Standardization of Drugs. Laboratory work 7 hours; first half-year. Professor LIEB. Half course.

ZOÖLOGY

Graduate major work in zoölogy requires at least two years of preparatory undergraduate study or the equivalent, *i.e.*, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses 1-4, 91-92 and 93. For minor or special work a less extensive preparation may suffice, but all candidates for minor work must have taken at least one year's work in zoölogy or elementary biology. Courses numbered below 100 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a sufficient standard of knowledge and training as shown by the master's essay or the doctor's dissertation. The course requirements for the degree of Doctor of Philosophy are approximately double those for the degree of Master of Arts (the latter requires eight full courses); in either case specially assigned study or research (to be registered as Course 227-228) may in part take the place of formal course-work. Courses 201 and 223-224 are recommended to all Ph.D. students who have their major subject in Zoölogy as a general foundation. Students who have not taken 91-92 as undergraduates may take 101-102 (counting as two of all courses) as part of their minor work; but these courses will not be accepted as part of the major work for the degree of Doctor of Philosophy.

All the graduate courses are open to women.

1-2—Elementary Biology (Zoölogy). C 2 hours, L 4 hours. Professors CALKINS and MCGREGOR (Columbia College); Professors CRAMPTON and OSBURN, Miss DEDERER, Dr. L. H. GREGORY (Barnard College).

3—Elementary Histology. 1 hour. Miss DEDERER (Barnard College).

4—Elementary Embryology. C 1 hour, L 2 hours. Professor MORGAN (Columbia College); Professor OSBURN (Barnard College).

5—General Biology. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

Prerequisite: Course 1-2.

6—Experimental Biology. An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

7-8—Biology and Genetic Relations of the Human Organism. General anatomy and physiology of the human type in comparison with other organisms; the biological basis of individual hygiene, of human genetics and social relations. Professor CRAMPTON and Dr. GREGORY. 4 points. (Barnard College.)

W. and F. at 3.

Open to students of all classes. Students who have previously taken Course 1-2 will receive only 2 points credit. This course does not count as fulfilling the prescribed requirement in science for the A.B. or B.S. degree.

9—Animal Variations and Their Significance. An introduction to the leading theories of modern biology. Open to all students of Columbia College. Lectures and discussions. 2 points. Professor CALKINS.

F., 1-3.

Prerequisite or parallel: Zoölogy 1, except by special permission of the instructor.

53-54—Practical Zoölogy and Embryology. 2 points. Miss DEDERER (Barnard College).

91-92—General Zoölogy. C 2 hours, L 6 hours. Professor MCGREGOR (Columbia College).

93—Comparative Embryology of Vertebrates. C 1 hour, L 2 hours. Professor MCGREGOR (Columbia College).

101-102—General Zoölogy. This course covers the same general ground as 91-92, but is supplemented by additional assigned work. It may not be counted as part of the major work toward the higher degrees. Professor MCGREGOR (Columbia College); Professors CRAMPTON and OSBURN, Miss DEDERER, Dr. L. H. GREGORY (Barnard College). 2 full courses.

103—Comparative Embryology of Vertebrates. Covers the same ground as 93 with additional assigned work. Half course. Professor MCGREGOR.

110—The Parasitic Protozoa. A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had Zoölogy 91 or its equivalent. Professor CALKINS. Full course.

113—Tropisms. This course deals with the simpler responses of

organisms to external factors and serves as an introduction to the next course, 114. One lecture a week. Professor MORGAN. Full course.

Prerequisite: 1-2, 91-92.

114—Instincts. An analysis of the more complex behavior of animals, and the problems of the evolution of instincts. One lecture a week. Professor MORGAN. Full course.

Prerequisite: 1-2, 91-92.

151-152—General Physiology. General principles of human and animal physiology. C 2 hours, L 4 hours. Professor OSBURN, Dr. L. H. GREGORY (Barnard College). 2 full courses.

A. Advanced General Zoölogy

The two following courses are designed to complete the work in general zoölogy begun in 1-2 and continued in 91-92, and are recommended to all students making zoölogy their major subject. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

201—Topics in Invertebrate Zoölogy, with Especial Reference to Problems of Phylogeny. 2 days a week. Professor WILSON. Double course.

223-224—Evolution of the Vertebrates. Structure, origin and phylogeny of the principal groups, living and extinct, from the protochordates upward. Structural adaptations. Principles of phylogeny. Evolution of the vertebrate skeleton. Study of recent and fossil material at the American Museum. 10 hours, lectures and laboratory. Dr. W. K. GREGORY. 2 full courses.

B. Embryology and Cellular Biology

208—General Embryology of Invertebrate Types. Seminar. Lectures, special reading, and laboratory work. 1 day a week. Professor CALKINS. Full course.

220—Cellular Embryology (see also 218 and 225-6). A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. One lecture a week and assigned work. Courses 93 and 208 form a desirable preparation. This and 218 are parallel courses which supplement each other. Professor WILSON. Full course.

225-226—Cellular Biology. General structure and functions of the cell. Professor WILSON. 2 full courses.

C. Morphology and Evolution of Special Groups

203-204—Mammals, Living and Fossil. Structure, origin and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum. 10 hours, lecture and laboratory. Dr. W. K. GREGORY. 2 full courses.

D. Protozoölogy

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life history, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Parasitic Protozoa (see page 23).

221-222—Protozoölogy. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology and physiology. Professor CALKINS. 2 full courses.

230—Experimental Protozoölogy. The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization and age. Individual research problems for registered students. Full course.

Prerequisite: 221.

E. Experimental Zoölogy

The following four courses (215-218 and 113-114) cover three years' work, each including one day a week. Each course may be taken independently of the others and not necessarily in the order given.

215-216—Experimental Zoölogy. This course includes a treatment of such questions as the influence of external conditions in modifying organisms and in affecting modes of reproduction; Mendelian heredity; the determination of sex. One lecture a week, with laboratory work on special problems. Professor MORGAN. 2 full courses.

217—Regeneration. The phenomena of regeneration are studied as bearing on the problem of growth. A principal feature of this course is the formulation of special problems for further investigation. 1 day a week. Professor MORGAN. Full course.

218—Experimental Embryology. The rôle of external factors in normal development. This course is parallel to 220, which treats of internal factors. One lecture a week. Special research. Professor MORGAN. Full course.

227-228—Special Research. Investigation of special problems in any of the subjects enumerated above, counting as half, full, or double course.

Course in the College of Physicians and Surgeons

101—Histology and Embryology. 12 hours. Professors SCHULTE and MILLER and Drs. STRONG and SHARP. Double course.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor BIGELOW, Miss BROADHURST and Miss STACKPOLE. See **Biology and Nature-Study** in Teachers College Announcement.

Courses under the George Crocker Special Research Fund

201—Morphology and Classification of Tumors, including Pathological Technique. Professor WOOD. One full course.
Prerequisite: Mammalian histology.

202—General Biology of Tumors. Professor WOGLOM. One full course.
Prerequisite: Mammalian histology.

205-206—Research in Problems of Growth Pathology with Especial Reference to Tumors. Professors WOOD and WOGLOM and Drs. PRIME and BULLOCK. Credit to be assigned in individual cases at the time of registration.

The laboratories of the George Crocker Special Research Fund are open to properly qualified workers for research in pathology under the supervision of the Director of Cancer Research.

Course in the College of Pharmacy

A laboratory course of 200 hours in the general biology of plants and animals is given in the College of Pharmacy.

Courses in Biometrical Methods

Anthropology 121—Anthropometry,—Biometrical Methods. This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the inter-relations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged. C 2 hours. Professor BOAS. Full course.

Anthropology 122—Anthropometry,—Growth. A discussion of the phenomena of growth with special relation to the influences of heredity and of environment. C 2 hours. Professor BOAS. Full course.

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DIVISION OF BIOLOGY

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COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1915-1916

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(Issued 25 times during the Academic year, monthly in November and December, and weekly between February and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under the Act of July 16, 1894.)

These include:

1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, price 25 cents, the Announcements of the several Colleges, and Schools and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University. For information as to the various courses offered by the University consult the last page of this Announcement.

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ABRIDGED ACADEMIC CALENDAR

The Academic year is thirty-seven weeks in length, ending on the second Wednesday in June. In 1915-16 the year begins on September 29, 1915, and ends on June 14, 1916. It is divided into two half years. In 1915-16 the second half-year begins on February 9, 1916. The Summer Session for 1915 begins on July 6 and ends on August 13.

The exercises of the University are suspended on Election Day, Thanksgiving Day, and the following two days, for two weeks at Christmas, on Washington's Birthday, from the Thursday before Good Friday through the following Monday, and on Memorial Day.

The complete Academic Calendar will be found at the end of this Announcement.

OFFICERS OF THE DIVISION OF BIOLOGY

GEORGE S. HUNTINGTON.....*Professor of Anatomy, Executive officer,
Department of Anatomy*

A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904;
LL.D., Jefferson Medical College, 1907.

HENRY FAIRFIELD OSBORN.....*Research Professor of Zoölogy*

A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901;
Princeton, 1902; Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.)
Christiana, 1911; Member of National Academy of Sciences.

EDMUND B. WILSON.....*Da Costa Professor of Zoölogy, Executive
officer, Department of Zoölogy*

Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D.,
1902; LL.D., Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.),
Leipsic, 1909; Member of National Academy of Sciences.

FREDERIC S. LEE.....*Dalton Professor of Physiology, Executive
officer, Department of Physiology*

A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.

BASHFORD DEAN.....*Professor of Vertebrate Zoölogy*

A.B., College of the City of New York, 1886; A.M., Columbia, 1889;
Ph.D., 1890; Chevalier de la Légion d'Honneur, 1910.

HENRY E. CRAMPTON.....*Professor of Zoölogy*

A.B., Columbia, 1893; Ph.D., 1899.

WILLIAM J. GIES.....*Professor of Biological Chemistry, Executive
officer, Department of Biological Chemistry*

B.S., Pennsylvania College, 1893; M.S., 1896; Ph.B., Yale, 1894; Ph.D.,
1897.

HERBERT MAULE RICHARDS...*Professor of Botany and Secretary of the
Division*

B.S., Harvard, 1891; Sc.D., 1895.

GARY N. CALKINS.....*Professor of Protozoölogy*

B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia,
1893.

MAURICE A. BIGELOW.....*Professor of Biology in Teachers College*

B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard,
1901.

RUSSELL BURTON-OPITZ.....*Associate Professor of Physiology*

M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.

THOMAS HUNT MORGAN.....*Professor of Experimental Zoölogy*

B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891;
Member of National Academy of Sciences.

BERN B. GALLAUDET.....*Assistant Professor of Anatomy*

A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.

JOHN HENRY LARKIN.....*Assistant Professor of Pathology*

A.B., Manhattan, 1891; M.D., Columbia, 1894.

JAMES HOWARD MCGREGOR.....*Associate Professor of Zoölogy*

B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.

- HERMANN VON W. SCHULTE.....*Associate Professor of Anatomy*
A.B., Trinity, 1897; M.D., Columbia, 1902.
- CARLTON CLARENCE CURTIS.....*Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.
- WILLIAM G. MACCALLUM.....*Professor of Pathology, Executive*
officer, Department of Pathology
A.B., Toronto, 1894; M.D., Johns Hopkins, 1897.
- TRACY E. HAZEN.....*Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- RAYMOND C. OSBURN.....*Assistant Professor of Zoölogy*
B.S., Ohio State, 1898; M.S., 1900; Ph.D., Columbia, 1906.
- ROBERT A. HARPER.....*Torrey Professor of Botany, Executive officer,*
Department of Botany
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences.
- WILLIAM G. MARQUETTE.....*Associate Professor of Botany*
Ph.G., Northwestern, 1895; B.S., Wisconsin, 1903; Ph.D., 1907.
- FRANK HENRY PIKE.....*Assistant Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- PAUL E. HOWE.....*Assistant Professor of Biological Chemistry*
B.S., Illinois, 1906; A.M., 1907; Ph.D., 1910.
- CHARLES C. LIEB.....*Assistant Professor of Pharmacology, Executive*
officer, Department of Pharmacology
A.B., Columbia, 1902; M.D., 1906.
- ADAM M. MILLER.....*Assistant Professor of Anatomy*
A.B., Princeton, 1901; A.M., 1902.
- JAMES W. JOBLING.....*Assistant Professor of Pathology*
M.D., Tennessee Medical College, 1897.
- HANS ZINSSER.....*Professor of Bacteriology, Executive*
officer, Department of Bacteriology
A.B., Columbia, 1899; A.M. and M.D., 1903.
- JEAN BROADHURST...*Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908.
- WALTER A. BASTEDO.....*Associate in Pharmacology and Therapeutics*
Ph.G., New York College of Pharmacy, 1894; M.D., Columbia, 1899.
- ALWIN M. PAPPENHEIMER.....*Associate in Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY.....*Associate in Anatomy*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- WALTER H. EDDY.....*Associate in Biological Chemistry*
B.S., Amherst, 1898; A.M., Columbia, 1908; Ph.D., 1909.
- HAVEN EMERSON.....*Associate in Physiology*
A.B., Harvard, 1896; A.M. and M.D., Columbia, 1899.

- HORATIO B. WILLIAMS.....*Associate in Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- ALFRED P. LOTHROP.....*Associate in Biological Chemistry*
A.B., Oberlin, 1906; A.M., 1907; Ph.D., Columbia, 1909.
- ROBERT A. LAMBERT.....*Associate in Pathology*
M.D., Tulane, 1907.
- WILLIAM K. GREGORY.....*Associate in Zoölogy*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- HERMAN O. MOSENTHAL.....*Associate in Biological Chemistry*
A.B., Columbia, 1899; M.D., 1903.
- J. GARDNER HOPKINS.....*Associate in Bacteriology*
A.B., Columbia, 1902; M.D., Johns Hopkins, 1907.
- OLIVER S. STRONG.....*Instructor in Anatomy*
A.B., Princeton, 1886; A.M., Columbia, 1892; Ph.D., 1896.
- J. VICTOR HABERMAN.....*Instructor in Neurology and in Psycho-
Therapeutics*
A.B., Columbia, 1903; M.D., 1905.
- PAULINE H. DEDERER.....*Instructor in Zoölogy in Barnard College*
A.B., Columbia, 1901; A.M., 1907.
- MARION E. LATHAM.....*Instructor in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- LOUISE H. GREGORY.....*Instructor in Zoölogy in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- LEANDER H. SHEARER.....*Instructor in Physiology*
A.B., Princeton, 1897; M.D., Columbia, 1901.
- FREDERICK B. HUMPHREYS.....*Instructor in Pathology*
Ph.B., Yale, 1899; M.D., Columbia, 1903.
- JAMES G. DWYER.....*Instructor in Bacteriology*
M.D., Queen's, 1905.
- WILLIAM K. TERRIBERRY.....*Instructor in Physiology*
A.B., Yale, 1903; M.D., Columbia, 1907.
- DONALD GORDON.....*Instructor in Physiology*
M.D., Columbia, 1906.
- ALFRED J. BROWN.....*Instructor in Anatomy*
A.B., Yale, 1899; M.D., Columbia, 1903.
- RICHARD DERBY.....*Instructor in Anatomy*
A.B., Harvard, 1903; M.D., Columbia, 1907.
- JOHN C. VAUGHAN.....*Instructor in Anatomy*
M.D., Columbia, 1907.
- ERNEST L. SCOTT.....*Instructor in Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911.

- JAMES CLAYTON SHARP.....*Instructor in Anatomy*
M.D., Columbia, 1901.
- FORDYCE B. ST. JOHN.....*Instructor in Anatomy*
B.S., Princeton, 1905; M.D., Columbia, 1909.
- BERNARD O. DODGE.....*Instructor in Botany*
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- FREDERIC G. GOODRIDGE.....*Instructor in Biological Chemistry*
A.B., Harvard, 1897; M.D., Columbia, 1901.
- ANTHONY C. FREEMAN.....*Instructor in Pharmacology*
A.B., Stanford University, 1906; M.D., Columbia, 1910.
- GEORGE M. GOODWIN.....*Instructor in Pharmacology*
- SERGIUS MORGULIS.....*Instructor in Biological Chemistry*
Ph.D., Harvard, 1910.
- REUBEN OTTENBERG.....*Instructor in Bacteriology*
A.B., Columbia, 1902; M.D., 1905.
- HAROLD E. B. PARDEE.....*Instructor in Physiology*
A.B., Columbia, 1906; M.D., 1909.
- MAURICE J. SITTENFIELD.....*Instructor in Pathology*
M.D., Bellevue Hospital Medical College, 1898.
- GEORGE R. DEMPSEY.....*Instructor in Pathology*
M.D., Cornell, 1911.
- CAROLINE STACKPOLE.....*Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- EMILY C. SEAMAN.....*Instructor in Household Arts in Teachers College*
B.S., Adelphi, 1899; A.M., Columbia, 1905; Ph.D., 1912.
- CHARLES PACKARD.....*Instructor in Zoölogy*
B.S., Syracuse, 1907; M.S., 1908; Ph.D., Columbia, 1913.
- EDGAR ALTENBURG.....*Assistant in Botany*
A.B., Columbia, 1911; A.M., 1912.
- ALBERT R. LAMB.....*Assistant in Pathology*
A.B., Yale, 1903; M.D., Columbia, 1907.
- WALDO SHUMWAY.....*Assistant in Zoölogy*
B.A., Amherst, 1911; A.M., Columbia, 1913.
- ARTHUR KNUDSON.....*Assistant in Biological Chemistry*
A.B., Missouri, 1912.
- OTTO KUNKEL.....*Research Assistant in Botany*
B.S., Missouri, 1909; A.B., 1910; A.M., 1911.
- HERMANN J. MULLER.....*Assistant in Zoölogy*
A.B., Columbia, 1910; A.M., 1911.
- CALVIN B. COULTER.....*Assistant in Pathology*
A.B., Williams, 1907; A.M., Princeton, 1908; M.D., Columbia, 1913.

CYRUS W. FIELD.....	<i>Assistant in Pathology</i>
DONNELL B. YOUNG.....	<i>Assistant in Zoölogy</i>
B.S., Amherst, 1911.	
ALLEN C. FRASER.....	<i>Assistant in Botany</i>
B.S., Cornell.	
WILLIAM A. PERLZWEIG.....	<i>Assistant in Biological Chemistry</i>
A.B., Columbia, 1913.	
FREDERICK V. RAND.....	<i>Assistant in Botany</i>
B.S., Vermont, 1908; M.S., 1911.	
MARY W. STEWART.....	<i>Assistant in Botany in Barnard College</i>
A.B., Columbia, 1913.	
ERNEST C. STILLMAN.....	<i>Assistant in Pathology</i>
A.B., Harvard, 1907; M.D., Columbia, 1913.	
VICTOR E. LEVINE.....	<i>Assistant in Biological Chemistry</i>
A.B., C. C. N. Y., 1909; A.M., Columbia, 1911.	
CHARLES WEISMAN.....	<i>Assistant in Biological Chemistry</i>
B.S., College of the City of New York, 1900; M.S., 1902; Ph.D., Columbia, 1913.	

Members of the Staff of the Botanical Garden Giving Instruction in the Division

NATHANIEL LORD BRITTON, Ph.D., Sc.D.	<i>Director</i>
WILLIAM ALPHONSO MURRILL, Ph.D.....	<i>Assistant Director</i>
ARLOW BURDETTE STOUT, Ph.D.....	<i>Director of Laboratories</i>
JOHN KUNKEL SMALL, Ph.D.....	<i>Head Curator of the Museums</i>
FRED. JAY SEAVER, Ph.D.....	<i>Curator</i>
PER AXEL RYBERG, Ph.D.....	<i>Curator</i>
ARTHUR HOLLICK, Ph.D.....	<i>Curator</i>
MARSHALL AVERY HOWE, Ph.D.....	<i>Curator</i>
GEORGE VALENTINE NASH.....	<i>Curator of the Plantations</i>
HENRY HURD RUSBY, M.D.....	<i>Curator of Economic Collections</i>
WILLIAM J. GIES, Ph.D.....	<i>Consulting Chemist</i>

Partial courses are also given by

ELIZABETH GERTRUDE BRITTON	EDWARD SANFORD BURGESS, Ph.D.
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GENERAL STATEMENT

Introductory

The Division of Biology includes the departments of Anatomy, Bacteriology, Biological Chemistry (Nutrition), Botany, Pathology, Physiology, Pharmacology, and Zoölogy in all schools of the University.

Students in this Division are received as candidates for the degrees of Master of Arts and Doctor of Philosophy under the Faculty of Pure Science. Certain courses which may be counted toward a higher degree are also offered in the Summer Session and in Extension Teaching.

Degrees

The requirements for the higher degrees are stated in full in a bulletin entitled "Instruction for Candidates for the Degrees of Master of Arts and Doctor of Philosophy," which will be sent upon application to the Secretary of the University. This bulletin contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments and all other University matters of interest to graduate students.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those for men.

Funds and Prizes

Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy

The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every

facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology

The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media and for the chemical study of bacterial products. The laboratories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

BIOLOGICAL CHEMISTRY

(Nutrition)

At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor Gies' library occupies a room adjoining the laboratory and is accessible by appointment to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoölogical Park for research, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany

The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultraviolet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammeters, resistance measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus afford facilities for experimental work in physiology and pathology and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic collections are in special rooms. Ample opportunity for experimental work in plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses.

The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

A seminar for the study of special subjects in general physiology meets weekly and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a bi-weekly colloquium.

Pathology

The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, amphitheater, photographic rooms, etc., on the fifth floor. On the fourth floor, there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a clinical laboratory, the museum, preparation rooms, cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology

The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises one large laboratory, which is provided with special apparatus for teaching purposes; one large and four small laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, mainly for research; a library containing sets of the physiological journals, monographs and other books, and many reprints of special articles; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoölogy

The zoölogical laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoölogy, and eight

rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the collections of the American Museum of Natural History (see below), the department does not maintain a general zoölogical museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, charts and wax models and an aquarium room.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoölogy and palæontology of invertebrates and vertebrates, both from the systematic and bionomic points of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoölogical Park in the Borough of the Bronx, under the direction of the New York Zoölogical Society, affords exceptional opportunities for the study of living reptiles, birds and mammals.

The New York Aquarium, also under the management of the Zoölogical Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets every week in the departmental library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former five investigators' rooms (ten tables) are subscribed for by the University for the use of the Department of Zoölogy; in the latter a table is available through the John D. Jones Scholarship. The University also maintains an investigators' table at the Naples Zoölogical Station.

Publications by Members of the Division

The University Press issues the *Columbia University Biological Series*, of which ten volumes have already appeared.

ANATOMY

Anatomy 101—Histology and Embryology. Lectures, conferences and laboratory work 12 hours; first half-year. Professor Schulte and Drs. Strong and Sharp. Double course.

Anatomy 103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences and dissections 12 hours. Drs. Brown and Vaughan. Two full courses.

Anatomy 105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work and dissection 12 hours; first half-year. Drs. Tilney, Strong and St. John. Double course.

Anatomy 107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations 3 hours; first half-year. Professor Huntington. Half course.

Anatomy 202—Special Morphology. 3 hours; second half-year. Professors Huntington and Schulte. Half course.

Anatomy 204—Morphology of the Nervous System. 3 hours; second half-year. Professor Tilney. Half course.

Anatomy 251-252—Research in Anatomy. Under the direction of the professor of anatomy. The officers of the department. Credit for this course varies from two half-courses to two double courses, according to the arrangement made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Anatomy 302—Seminar in Histology and Embryology. 1 hour; second half-year. Professor Schulte. No course credit.

BACTERIOLOGY

Preliminary Statement

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. No preliminary work in bacteriology is required. There are no courses in this department

providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoölogy in the Department of Zoölogy.

Courses **201** and **203**, **205-206**, **208**, **211-212**, **251-252** are open to women.

Bacteriology 101—General Bacteriology, especially adapted to the requirements of students of medicine. 6 hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. Professor Zinsser and Drs. Hopkins, Dwyer and Mr. Bliss. Full course.

Bacteriology 201—Advanced Bacteriology. This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides.

Text-books: Hiss and Zinsser's Text-book of Bacteriology, Kolle u. Wassermann's Handbuch d. Pathogenen Mikroorganismen, Macé's Bacteriologie.

The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon in October, November, December and January. Professor Zinsser, Dr. Hopkins and Dr. Dwyer. Double course.

Bacteriology 203—Special Bacteriology. As under Course **201**, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; practical work in photomicrography, and the pursuit of some selected theme for original investigation. Professor Zinsser, and Dr. Hopkins. Credit individually determined for each case at the time of registration.

Text-books: Hiss and Zinsser's Text-book of Bacteriology, Kolle u. Wassermann's Handbuch der Pathogenen Mikroorganismen.

Attendance and hours as in Course **201**, with additional time for research.

Bacteriology 205-206—The Principles of Infection, Immunity, Serum Diagnosis and Therapy. Lectures with demonstrations 1 hour. Professor Zinsser. Half course.

Bacteriology 208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twelve students. Professor Zinsser, Dr. Hopkins, Dr. Ottenberg. Full course.

Bacteriology 209-210—Clinical Bacteriology. A course will be given at the laboratory of the Manhattan Eye, Ear and Throat Hospital in which a small group of students will be taught the methods of examining material from patients suffering from infections chiefly of the eye, ear, nose and throat, and course will include the bacteriological diagnosis of material, the making of blood cultures, the making of autogenous vaccines and their use in the treatment of patients, etc. Dr. Dwyer. Half-course each half year.

Bacteriology 211-212—Clinical Serology. Technique of Wassermann reaction and other clinical serum reactions. Laboratory open to properly qualified graduate students, to physicians and to undergraduates who have taken courses **205-206** and **208**. Dr. Ottenberg and Assistants. Half-course each half year.

Bacteriology 251-252—Research in Bacteriology. Under the direction of the professor of bacteriology. Professor Zinsser and staff. Credit individually determined at the time of registration.

Summer Session

Bacteriology S101—General Bacteriology. 2 points, equivalent to Course 101. Dr. Hopkins and Dr. Dwyer. Full course.

Course in Teachers College

A course in bacteriology applied to household arts is given in Teachers College by Miss Broadhurst.

Course in the College of Pharmacy

A laboratory course of 32 hours in Bacteriology is given in the College of Pharmacy.

BIOLOGICAL CHEMISTRY**(Nutrition)***Courses in Nutrition (Physiological and Pathological Chemistry)*

Biological Chemistry 101 or 102—General Physiological Chemistry. A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes. C 1 hour, L 7 hours. Full course.

Required, in the second half of the first year, of candidates for M.D. Open as an elective to qualified Juniors and Seniors of Columbia College. Professors Gies and Howe, Drs. Horowitz and Levine, and Mr. Perlzweig.

Biological Chemistry 202—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Household Arts.) C 1 hour, L 6 hours. Professor Gies and Misses Heft and Coleman. Full course.

Biological Chemistry 211-212—Biochemical Methods of Research, including Clinical Methods. C 1 hour, L 7 hours. Dr. Miller and Mr. Bersohn. Two full courses.

Biological Chemistry 221-222—Nutrition in Health (advanced physiological chemistry). C 2 hours, L 14 hours. Professor Howe, Dr. Miller and Mr. Emmett. Two double courses.

Biological Chemistry 213-214—Chemistry of Biological Colloids. C 1 hour, L 7 hours. Two full courses. Professor Gies.

Biological Chemistry 223-224—Nutrition in Disease (general pathological chemistry). C 2 hours, L 14 hours. Professor Gies. Two double courses.

Biological Chemistry 225-226—Nutrition in Disease. C 2 hours. Drs. Goodridge, Kahn, and Weinberger. Two half courses.

Biological Chemistry 251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 20 hours. Professor Gies and Dr. Miller. Two double courses.

Toxicological Chemistry

Biological Chemistry 261-262—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L 10 hours. Professor Gies. Two full courses.

Botanical Chemistry

Biological Chemistry 271-272—Chemical Physiology of Plants. C 1 hour, L 7 hours. Professor Gies. Two full courses. (The

course may be taken in whole or in part at the New York Botanical Garden, where Professor Gies is consulting chemist.) See Botany, page 16.

Bacteriological Chemistry

Biological Chemistry **281-282**—**Chemistry of Micro-organisms; Fermentations, Putrefactions, and Enzyme Actions in General** (introduction to sanitary chemistry). C 1 hour, L 7 hours. Professor Gies. Two full courses.

Seminar

Biological Chemistry **301-302**—The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department, meet weekly to discuss results of recent researches in chemical biology. 1 hour. Professor Gies. No course credit.

Summer Session

(See separately printed announcements)

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University. It also issues the quarterly **BIOCHEMICAL BULLETIN**.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering upon major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses **1-2**, **3-4** and **101-102** for men or Courses **51-52**, **53-54**, **153** and **154** or **156** for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes also the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major requirement must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

Minor work in botany presupposes two years' preparation in the subject, with at least four full courses for the degree of Doctor of Philosophy or two full courses for the degree of Master of Arts.

All graduate courses are open to women.

Hours and credit for courses in research (Botany 200 to 244) are arranged on consultation and should be recorded at the office of the Registrar.

Botany 1-2—General Botany. C 2 and L 4 hours. Professor Curtis and Mr. Altenburg.

Botany 3-4—Plant Morphology. C 2 and L 4 hours. Professors Harper and Curtis.

Botany 5—Elementary Plant Pathology. C 1, L 3 hours. Dr. Dodge.

Botany 6—Economic Botany. C 1 hour, L 3 hours. Dr. Dodge.

Botany 7—Growth and Character of Timber. C 1 hour, L 3 hours. Professor Curtis and Mr. Altenburg.

Botany 9-10—Botanical Problems. Introductory to research. Professors Harper, Curtis and Marquette.

Botany 11-12—Plant Anatomy and Histology. C 2, L 4 hours. Professor Marquette.

Botany 101-102—Plant Physiology. C 2 hours, L 6 hours. Professor Marquette. Two full courses.

Botany 103-104—Structure and Development of Plants. A general survey of the plant kingdom from the standpoint of structure and phylogeny. Professors Harper and Curtis. Two full courses.

Botany 113-114—Morphology of the Higher Plants. Study of the orders, including the structure and relationships of plants. Professor Curtis and Mr. Altenburg. Two full courses.

Botany 115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. Professor Harper and Dr. Dodge. Two full courses.

Botany 117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. Professor Harper and Dr. Dodge. Two full courses.

Botany 120—Plant Reactions. Lectures and demonstrations on the responses of plants to external stimuli. Professor Marquette. Half-course.

Botany 201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. Professors Richards, Curtis and Marquette.

Botany 209-210—Physiology of Nutrition.—treated from a chemical standpoint. Professors Richards and Gies.

Botany 211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. Professor Harper, Dr. Murrill and Dr. Seaver.

Botany 217-218—Embryology of Spermatophyta. With special work during two summers. Professors Curtis and Hazen.

Botany 219-220—Morphology. Work dealing with morphological problems in the various groups of plants. Directed by members of the department and Botanical Garden staff.

Botany 227-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. Directed by members of the Botanical Garden staff.

Botany 235-236—Plant Distribution. Problems dealing with regional botany or plant geography. Professor Britton and other members of the staff.

Botany 239-240—Developmental Taxonomy. Fossil ancestors of some family of plants. Dr. Hollick.

Botany 241-242—Research on the Physiology of the Cell and Reproduction. Professor Harper.

Botany 243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. Dr. Stout.

Botany 301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. Professor Harper.

COLLOQUIUM—A biweekly meeting for the discussion of current botanical literature.

CONFERENCE—A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Botany 51-52—Principles of Plant Morphology and Physiology. C 2 hours, L 4 hours. Professor Richards, Misses Latham and Stewart (Barnard).

Botany 53-54—**General Morphology and Development of Plants.** C 2 hours, L 4 hours. Professor Hazen and Miss Stewart (Barnard).

Botany 55-56—**Morphology and Classification of Spermatophytes.** Study of the Natural Orders. C 1 hour, L 4 or 6 hours. Professor Hazen.

Botany 153—**Anatomy of Vascular Plants.** C 2 hours and a minimum of L 6 hours. Miss Latham (Barnard). Full course.

Botany 154—**Physiology of Plants from Standpoint of Nutrition.** C 2 hours and a minimum of L 6 hours. Professor Richards and Miss Latham (Barnard). Full course.

[Botany 156—**Physiology of Plants from Standpoint of Growth.** C 2 hours and a minimum of L 6 hours. Professor Richards and Miss Latham (Barnard). Full course. Not given 1915-16.]

Botany 158—**Structure and Development of Algæ.** Advanced course. C 1 hour, L 8 hours. Professor Hazen. Full course.

Botany 159—**Structure and Development of Fungi.** Advanced course. C 1 hour, L 8 hours. Professor Richards. Full course.

Courses 158-59 are not usually given the same year.

Botany 160—**Embryology and Laboratory Methods.** Practice in methods of technique, with the study of the embryology of one or more types. L 8 hours with occasional lectures and outside reading. Professor Hazen. Full course.

Botany 161-162—**Advanced Physiology and Morphology.** Work will be arranged to suit the needs of the students. Professors Richards and Hazen and Miss Latham (Barnard). Half, full or double course each half-year.

Summer Session and Extension Teaching

(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain prerequisite courses in subject-matter education, are given in the Department of Biology of Teachers College by Professor Bigelow, Miss Broadhurst and Miss Stackpole. See Biology and Nature-Study in Teachers College Announcement.

Courses in the College of Pharmacy

A course of 30 lectures, 30 recitation hours and 75 hours laboratory work in structural and descriptive botany; a laboratory course of 90 hours in botany applied to the study of drugs; and a course of 30 hours in plant classification are given in the College of Pharmacy.

Courses in Biometrical Methods

See page 28

PATHOLOGY

Pathology **101-102—General and Special Pathology.** 3 hours, first half, and 9 hours, second half. Professors MacCallum and Pappenheimer, Dr. Lambert, and others. Two full courses.

Pathology **105-106—Gross Pathological Anatomy and Attendance Upon Autopsies.** 2 hours and at other times as occasion offers. Professors MacCallum and Pappenheimer and Drs. Field, Lamb, and others. One half course each half year.

Pathology **107—Experimental Pathology.** 3 hours; limited to twelve students. Professor MacCallum. Half course.

Pathology **201-202—Advanced Pathology.** The officers of the department. Credit for this course varies from one-half course to one double course each half-year, according to arrangements made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Pathology **251-252—Research in Pathology.** Under the direction of the professor of Pathology. The officers of the department. Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

See also additional courses listed under George Crocker Special Research Fund on page 28.

PHARMACOLOGY.

Pharmacology **213-214—General Pharmacology.** Lectures, 1 hour; laboratory work, 6 hours. Professor Lieb and Dr. Freeman. Two full courses.

Pharmacology **215—Biological Standardization of Drugs.** Laboratory work 7 hours; first half-year. Professor Lieb. Half course.

PHYSIOLOGY

Physiology **106-107—Human Physiology.** Lectures 3 hours; demonstrations 1 hour; recitations 2 hours; laboratory work 3 hours. Professor Burton-Opitz and Drs. Gordon, Pardee, Shearer, Terry and Williams. Two full courses.

Physiology **201-202—General Physiology.** Lectures 1 hour; laboratory work 5 hours. Professor Pike and Dr. Scott. Two full courses.

Physiology **203-204—Special Physiology.** Lectures 1 hour; laboratory work 5 hours. Professors Burton-Opitz and Pike and Drs. Scott and Williams. Two full courses.

Physiology **205-206—Problems of Evolution from the Standpoint of Physiology.** Lectures 1 hour. Professor Pike. Half course.

For graduate students 205 and 206 together will be credited as a half-course.

Physiology **251-252—Research in Physiology.** Under the direction of Professor Lee. The officers of the department. Hours to be arranged. Credit for this course varies from one half-course each half-year to two double courses, according to the arrangement made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Course in Columbia College

Physiology **2—Elementary Physiology.** C 2 hours, L 4 hours. 619 S. Dr. Scott. 3 points.

Courses in Barnard College

A course in general Animal Physiology is given by the Department of Zoölogy of Barnard College, supplementing the work in general Biology and Zoölogy. (See p. 26.) Professor Osburn and Dr. L. H. Gregory.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College (see p. 21): One dealing with Plant Nutrition, Botany **154**, a second with Growth, Botany **156**, a third with advanced problems in physiology, Botany **161-162**. Professor Richards and Miss Latham.

Summer Session

(See separately printed announcement)

Courses in Teachers College

The courses in Applied Biology given in Teachers College are chiefly physiological. Professor Bigelow, Miss Broadhurst and Miss Stackpole. See Teachers College Announcement.

Course in the College of Pharmacy

A course of 30 lectures and 30 recitations in Human Physiology is given in the College of Pharmacy.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, pp. 19 and 20. They include Courses Nos. **101** and **102**, General Plant Physiology (Professor Marquette); **120**, Plant Reactions (Professor Marquette); **201-208**, Advanced Physiology (Professors Richards, Curtis and Marquette); Physiology of Nutrition (Professors Richards and Gies).

Journal Club

A journal club, composed of the members of the staff and graduate students, holds weekly meetings for the discussion of current literature and special investigations.

PRACTICE OF MEDICINE

Practice of Medicine **211** or **212**—Psychopathology and Psychotherapy, inclusive of the Pathology, Psychotherapy and Mental Examinations of the Psychopathic Child. At the Vanderbilt Clinic; clinical lectures; one hour for one-half year. Dr. Haberman. Half course. This course may be elected for either the first or the second half-year.

ZOOLOGY

Graduate major work in zoölogy requires at least two years of preparatory undergraduate study or the equivalent, i.e., an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses **1-4**, **91-92** and **93**. For minor or special work a less extensive preparation may suffice, but all candidates for minor work must have taken at least one year's work in zoölogy or elementary biology. Courses numbered below 100 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a sufficient standard of knowledge and training as shown by the master's essay or the doctor's dissertation. The course requirements for the degree of Doctor of

Philosophy are approximately double those for the degree of Master of Arts (the latter requires eight full courses); in either case specially assigned study or research (to be registered as Course 227-228) may in part take the place of formal course-work. Courses 201 and 223-224 are recommended to all Ph.D. students who have their major subject in Zoölogy as a general foundation. Students who have not taken 91-92 as undergraduates may take 101-102 (counting as two full courses) as part of their minor work; but these courses will not be accepted as part of the major work for the degree of Doctor of Philosophy.

All the graduate courses are open to women.

1-2—Elementary Biology (Zoölogy). C 2 hours, L 4 hours. Professors Calkins and McGregor, Dr. Packard (Columbia College); Professors Crampton and Osburn, Miss Dederer, Dr. L. H. Gregory (Barnard College).

3—Elementary Histology. 1 hour. Miss Dederer (Barnard College).

4—Elementary Embryology. C 1 hour, L 2 hours. Professor Morgan (Columbia College); Professor Osburn (Barnard College).

5—General Biology. C 1 hour, L 2 hours. Professor Crampton (Barnard College).

Prerequisite: Course 1-2.

6—Experimental Biology. An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. C 1 hour, L 2 hours. Professor Crampton (Barnard College).

7-8—Biology and Genetic Relations of the Human Organism. General anatomy and physiology of the human type in comparison with other organisms; the biological basis of individual hygiene, of human genetics and social relations. Professor Crampton and Dr. Gregory. 4 points. (Barnard College).

W. and F. at 3.

Open to students of all classes. Students who have previously taken Course 1-2 will receive only 2 points credit. This course does not count as fulfilling the prescribed requirement in science for the A.B. or B.S. degree.

9—Theories of Modern Biology. Open to qualified students of Columbia College. Lectures and discussions. 2 points. Professor Calkins.

F., 1-3. 619 S.

Prerequisite: Zoölogy 1, except by special permission of the instructor.

51—Histology and Technique. The preparation and study of animal tissues. C 1, L 4 hours. Dr. Packard.

53-54—Practical Zoölogy and Embryology. 2 points. Miss Dederer (Barnard College).

91-92—General Zoölogy. C 2 hours, L 6 hours. Professor McGregor (Columbia College).

93—Comparative Embryology of Vertebrates. C 1 hour, L 2 hours. Professor McGregor (Columbia College).

101-102—General Zoölogy. This course covers the same general ground as **91-92**, but is supplemented by additional assigned work. It may not be counted as part of the major work toward the higher degrees. Professor McGregor (Columbia College); Professors Crampton and Osburn, Miss Dederer, Dr. L. H. Gregory (Barnard College). 2 full courses.

103—Comparative Embryology of Vertebrates. Covers the same ground as **93** with additional assigned work. Half course. Professor McGregor.

110—The Parasitic Protozoa. A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had Zoölogy **91** or its equivalent. Professor Calkins. Full course.

113—Tropisms. This course deals with the simpler responses of organisms to external factors and serves as an introduction to the next course, **114**. One day a week. Professor Morgan. Full course. Prerequisite: **1-2, 91-92**.

114—Instincts. An analysis of the more complex behavior of animals, and the problems of the evolution of instincts. One day a week. Professor Morgan. Full course. Prerequisite: **1-2, 91-92**.

151-152—General Physiology. General principles of human and animal physiology. C 2 hours, L 4 hours. Professor Osburn, Dr. L. H. Gregory (Barnard College). 2 full courses.

A. Advanced General Zoölogy

The two following courses are designed to complete the work in general zoölogy begun in **1-2** and continued in **91-92**, and are recommended to all students making zoölogy their major subject. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

201—Topics in Invertebrate Zoölogy, with Especial Reference to Problems of Phylogeny. 2 days a week. Professor Wilson. Double course.

223-224—Evolution of the Vertebrates. I (223), Fishes Recent and Fossil. II (224) Amphibia and Reptiles; Origin of the Birds; Origin of the Mammals. Systematic, phylogenetic and morphological studies. Evolution of the head and locomotive apparatus of vertebrates. One day a week, at the American Museum. Dr. W. K. Gregory, 2 full courses.

The material studied comprises over 700 specimens of recent and fossil types.

B. Embryology and Cellular Biology

208—General Embryology of Invertebrate Types. Seminar. Lectures, special reading, and laboratory work. 1 day a week. Professor Calkins. Full course.

220—Cellular Embryology (see also 218 and 225-6). A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. One lecture a week and assigned work. Courses 93 and 208 form a desirable preparation. This and 218 are parallel courses which supplement each other. Professor Wilson. Full course.

225-226—Cellular Biology. General structure and functions of the cell. Professor Wilson. 2 full courses.

C. Morphology and Evolution of Special Groups

203-204—Mammals, Living and Fossil. Structure, origin and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum. 10 hours, lecture and laboratory. Dr. W. K. Gregory. 2 full courses.

D. Protozoölogy

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life history, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Parasitic Protozoa (see page 23).

221-222—Protozoölogy. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology and physiology. Professor Calkins. 2 full courses.

230—Experimental Protozoölogy. The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization and age. Individual research problems for registered students. Full course.

Prerequisite: **221**.

E. Experimental Zoölogy

The following four courses (**215-218** and **113-114**) cover three years' work, each including one day a week. Each course may be taken independently of the others and not necessarily in the order given.

215-216—Experimental Zoölogy. This course includes a treatment of such questions as the influence of external conditions in modifying organisms and in affecting modes of reproduction; Mendelian heredity; the determination of sex. One lecture a week, with laboratory work on special problems. Professor Morgan. **2** full courses.

217—Regeneration. The phenomena of regeneration are studied as bearing on the problem of growth. A principal feature of this course is the formulation of special problems for further investigation. 1 day a week. Professor Morgan. Full course.

218—Experimental Embryology. The rôle of external factors in normal development. This course is parallel to **220**, which treats of internal factors. One lecture a week. Special research. Professor Morgan. Full course.

F. Special Research

227-228—Investigation of special problems in any of the subjects enumerated above, counting as half, full, or double course.

Courses in the College of Physicians and Surgeons

101—Histology and Embryology. 12 hours. Professors Schulte and Miller and Drs. Strong and Sharp. Double course.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professor Bigelow, Miss Broadhurst and Miss Stackpole. See **Biology and Nature-Study** in Teachers College Announcement.

Courses under the George Crocker Special Research Fund

201—Morphology and Classification of Tumors, including Pathological Technique. Professor Wood. One full course.

Prerequisite: Mammalian histology.

202—General Biology of Tumors. Professor Woglom. One full course.

Prerequisite: Mammalian histology.

205-206—Research in Problems of Growth Pathology with Especial Reference to Tumors. Professors Wood and Woglom and Drs. Prime and Bullock. Credit to be assigned in individual cases at the time of registration.

The laboratories of the George Crocker Special Research Fund are open to properly qualified workers for research in pathology under the supervision of the Director of Cancer Research.

Course in the College of Pharmacy

A laboratory course of 200 hours in the general biology of plants and animals is given in the College of Pharmacy.

Courses in Biometrical Methods

Anthropology 121—Anthropometry,—Biometrical Methods. This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the inter-relations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged. C 2 hours. Professor Boas. Full course.

Anthropology 122—Anthropometry,—Growth. A discussion of the phenomena of growth with special relation to the influences of heredity and of environment. C 2 hours. Professor Boas. Full course.

ACADEMIC CALENDAR

1915-1916

1915

- Sept. 13—Monday. Last day for filing applications for entrance, advanced standing and deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 20—Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.
- Sept. 22—Wednesday. **Registration begins.**
- Sept. 28—Tuesday. Registration ceases for students previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 29—Wednesday. **First half-year, 162d year, begins.**
Registration ceases for students not previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.
Fellows and scholars to report to the Registrar.
- Oct. 2—Saturday. Registration ceases in the graduate schools. The privilege of later application may be granted up to October 23 on payment of a fee of \$5.
- Oct. 5—Tuesday. Last day for filing essay for the degree of Master of Arts, if the degree is to be conferred in October.
- Oct. 9—Saturday. Last day for filing applications for all degrees to be conferred in October, except Master of Arts and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Oct. 19—Tuesday. Stated meeting of University Council.
- Oct. 23—Saturday. Last day for receiving late applications for registration in the graduate schools.
- Nov. 2—Tuesday. Election Day, holiday.
- Nov. 24—Wednesday. **Annual Thanksgiving Service in St. Paul's Chapel.**
- Nov. 25—Thursday, to November 27, Saturday, inclusive, Thanksgiving holidays.

- Dec. 1—Wednesday. Last day for filing applications for the degree of Master of Arts to be conferred in February. The privilege of later application may be granted up to December 15 on payment of a fee of \$5.
- Dec. 12—Sunday. **Annual Commemoration Service** in St. Paul's Chapel.
- Dec. 21—Tuesday. Stated meeting of University Council.
- Dec. 22—Wednesday, to

1916

- Jan. 4—Tuesday, inclusive. Christmas holidays.
- Jan. 13—Thursday. Last day for filing applications for entrance examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Jan. 20—Thursday. Mid-year entrance examinations begin.
- Jan. 26—Wednesday. Mid-year examinations begin.
- Feb. 1—Tuesday. Last day for filing essay for the degree of Master of Arts, if the degree is to be conferred in February.
- Feb. 8—Tuesday. First half-year ends.
- Feb. 9—Wednesday. **Second half-year begins.**
University Service in St. Paul's Chapel.
Registration ceases for students entering second half-year. The privilege of later application may be granted up to March 4 in the graduate schools on payment of a fee of \$5.
Fellows and Scholars to report to the Registrar.
- Feb. 10—Thursday. Last day for filing applications for all degrees to be conferred in February, except Master of Arts and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Feb. 12—Saturday. Alumni Day.
- Feb. 15—Tuesday. Stated meeting of University Council.
- Feb. 22—Tuesday. Washington's Birthday, holiday.
- Mar. 1—Wednesday. Last day for filing applications for University Fellowships and Scholarships. Last day for filing applications for the degree of Master of Arts to be conferred in June. The privilege of later application may be granted up to March 15 on payment of a fee of \$5.
- Mar. 4—Saturday. Last day for receiving late applications for registration in the graduate schools.

- Apr. 1—Saturday. Last day for filing applications for examination for the degree of Doctor of Philosophy, if the degree is to be conferred in June.
- Apr. 18—Tuesday. Stated meeting of University Council.
- Apr. 19—Wednesday. Last day for filing applications for all degrees to be conferred in June, except Master of Arts and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Apr. 20—Thursday, to April 24, Monday, inclusive, Easter holidays.
- Apr. 25—Tuesday. Last day for filing applications for deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.
- May 1—Monday. Last day for students in Columbia College to file choice of studies for following year. The privilege of filing such choice later may be granted on payment of a fee of \$5. Last day for filing applications for scholarships in the Schools of Law, Applied Science and Architecture
- May 22—Monday. Final examinations begin.
- May 24—Wednesday. Last day for filing essay for the degree of Master of Arts, if the degree is to be conferred in June
- May 30—Tuesday. Memorial Day, holiday.
- June 4—Sunday. Baccalaureate Service.
- June 5—Monday. Class Day.
- June 7—Wednesday. Commencement Day.
- June 14—Wednesday. Second half-year ends.
- June 19—Monday. Entrance examinations begin.
- July 5—Wednesday. Seventeenth Summer Session opens.
- Aug. 1—Tuesday. Last day for filing applications for the degree of Master of Arts to be conferred in October. The privilege of later application may be granted up to August 15 on payment of a fee of \$5.
- Aug. 16—Wednesday. Seventeenth Summer Session closes.
- Sept. 11—Monday. Last day for filing applications for entrance, advanced standing and deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 18—Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.
- Sept. 20—Wednesday. Registration begins.

Sept. 26—Tuesday. Registration ceases for students previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.

Sept. 27—Wednesday. **First half-year, 163d year, begins.**

Registration ceases for students not previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.

Fellows and Scholars to report to the Registrar.

Sept. 30—Saturday. Registration ceases in the graduate schools. The privilege of later application may be granted up to October 21 on payment of a fee of \$5.

The last day of the second half-year falls on the second Wednesday in June, and the academic year opens 37 weeks before that date. The second half-year opens on Wednesday, 19 weeks from the opening of the first half-year.

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44/17

Series, No. 18

May 20, 1916



Columbia University Bulletin of Information

DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PATHOLOGY, PHARMA-
COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1916-1917

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1. The President's Annual Report to the Trustees.
2. The Catalogue of the University, price 25 cents, the Announcements of the several Colleges and Schools and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University. For information as to the various courses offered by the University consult the last page of this Announcement.

McM.—2500-1916.

OFFICERS OF THE DIVISION OF BIOLOGY

- GEORGE S. HUNTINGTON. *Professor of Anatomy, Executive officer, Department of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D., Jefferson Medical College, 1907.
- HENRY FAIRFIELD OSBORN. *Research Professor of Zoology*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901; Princeton, 1902; Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.) Christiana, 1911; Member of National Academy of Sciences.
- EDMUND B. WILSON. *Da Costa Professor of Zoology, Executive officer, Department of Zoology*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902; LL.D., Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.), Leipsic, 1909; Member of National Academy of Sciences.
- FREDERIC S. LEE. *Dalton Professor of Physiology, Executive officer, Department of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN. *Professor of Vertebrate Zoology*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D., 1890; Chevalier de la Légion d'Honneur, 1910.
- HENRY E. CRAMPTON. *Professor of Zoology*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES. *Professor of Biological Chemistry, Executive officer, Department of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Sc.D., 1914; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS. *Professor of Botany and Secretary of the Division*
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS. *Professor of Protozoology*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.
- MAURICE A. BIGELOW. *Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- RUSSELL BURTON-OPITZ. *Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN. *Professor of Experimental Zoology*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; LL.D., 1915; Member of National Academy of Sciences.
- BERN B. GALLAUDET. *Assistant Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.
- JAMES HOWARD MCGREGOR. *Associate Professor of Zoology*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- HERMANN VON W. SCHULTE. *Associate Professor of Anatomy*
A.B., Trinity, 1897; M.D., Columbia, 1902.

- CARLTON CLARENCE CURTIS.....*Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.
- WILLIAM G. MACCALLUM.....*Professor of Pathology, Executive*
officer, Department of Pathology
A.B., Toronto, 1894; M.D., Johns Hopkins, 1897.
- TRACY E. HAZEN.....*Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- ROBERT A. HARPER.....*Torrey Professor of Botany, Executive*
officer, Department of Botany
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences.
- WILLIAM G. MARQUETTE.....*Associate Professor of Botany*
Ph.G., Northwestern, 1899; B.S., Wisconsin, 1903; Ph.D., 1907.
- FRANK HENRY PIKE.....*Associate Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- PAUL E. HOWE.....*Assistant Professor of Biological Chemistry*
B.S., Illinois, 1906; A.M., 1907; Ph.D., 1910.
- CHARLES C. LIEB.....*Assistant Professor of Pharmacology, Executive*
officer, Department of Pharmacology
A.B., Columbia, 1902; M.D., 1906.
- HANS ZINSSER.....*Professor of Bacteriology, Executive*
officer, Department of Bacteriology
A.B., Columbia, 1899; A.M. and M.D., 1903.
- ALWIN M. PAPPENHEIMER.....*Assistant Professor of Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY.....*Professor of Neurology*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- JEAN BROADHURST.....*Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908; Ph.D., Cornell, 1914.
- JESSE F. WILLIAMS...*Assistant Professor of Physical Education, Teachers College*
A.B., Oberlin, 1909; M.D., Columbia, 1915.
- J. GARDNER HOPKINS.....*Assistant Professor of Bacteriology*
A.B., Columbia, 1902; M.D., Johns Hopkins, 1907.
- HORATIO B. WILLIAMS.....*Assistant Professor of Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- WILLIAM K. GREGORY.....*Assistant Professor of*
Vertebrate Palaeontology
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- CALVIN B. COULTER.....*Associate in Pathology*
A.B., Williams, 1907; A.M., Princeton, 1908; M.D., Columbia, 1913.
- FREDERIC G. GOODRIDGE.....*Associate in Biological Chemistry*
A.B., Harvard, 1897; M.D., Columbia, 1901; Ph.D., 1915.
- BENJAMIN HOROWITZ.....*Associate in Biological Chemistry*
Chemist, Columbia, 1911; A.M., 1912; Ph.D., 1913.
- ROBERT A. LAMBERT.....*Associate in Pathology*
M.D., Tulane, 1907.

- GEORGE M. MACKENZIE.....Associate in Pathology
A.B., Columbia, 1907; M.D., 1913.
- EDGAR G. MILLER, JR.....Associate in Biological Chemistry
B.S., Gettysburg 1911; Ph.D., Columbia, 1913.
- ERNEST L. SCOTT.....Associate in Physiology
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911; Ph.D., Columbia, 1914.
- WILLIAM WEINBERGER.....Associate in Biological Chemistry
M.D., Vienna, 1894; M.S., New York University, 1901.
- JOSEPH S. WHEELWRIGHT.....Associate in Physiology
A.B., Yale, 1897; M.D., Cornell, 1900.
- FRANK WARNER BISHOP.....Instructor in Physiology
B.S., Columbia, 1910; M.D., 1912.
- ALFRED J. BROWN.....Instructor in Anatomy
A.B., Yale, 1899; M.D., Columbia, 1903.
- WERA DANTSCHAKOFF.....Instructor in Anatomy
M.D., Moscow.
- PAULINE H. DEDERER.....Instructor in Zoology in Barnard College
A.B., Columbia, 1901; A.M., 1907; Ph.D., 1915.
- BERNARD O. DODGE.....Instructor in Botany
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- JAMES G. DWYER.....Instructor in Bacteriology
M.D., Queen's, 1905.
- ANTHONY C. FREEMAN.....Instructor in Pharmacology
A.B., Stanford, 1906; M.D., Columbia, 1910.
- DONALD GORDON.....Instructor in Physiology
M.D., Columbia, 1906.
- LOUISE H. GREGORY.....Instructor in Zoology in Barnard College
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- J. VICTOR HABERMAN.....Instructor in Psycho-Therapeutics
A.B., Columbia, 1903; M.D., 1905.
- FRANCIS WENGER HEAGEY, M.D.....Instructor in Anatomy
A.B., Princeton, 1908; M.D., Columbia, 1912.
- BENJAMIN S. KLINE, M.D.....Instructor in Pathology
A.B., Swarthmore, 1907; M.D., Johns Hopkins, 1911.
- WALTER M. KRAUS.....Instructor in Biological Chemistry
A.B., Harvard, 1909; M.D., Johns Hopkins, 1913; A.M., Columbia, 1914.
- FLORENCE DE L. LOWTHER.....Instructor in Zoology in Barnard College
A.B., Columbia, 1912; A.M., 1915.
- MALCOLM MCBURNEY.....Instructor in Bacteriology
A.B., Harvard, 1906; M.D., Columbia, 1910.
- ALEXANDER T. MARTIN.....Instructor in Pharmacology
B.S., Princeton, 1909; M.D., Pennsylvania, 1913.
- SERGIUS MORGULIS.....Instructor in Biological Chemistry
Ph.D., Harvard, 1910.
- REUBEN OTTENBERG, M.D.....Instructor in Bacteriology
A.B., Columbia, 1902; M.D., 1905.

- CHARLES PACKARD.....*Instructor in Zoology*
B.S., Syracuse, 1907; M.S., 1908; Ph.D., Columbia, 1914.
- HAROLD E. B. PARDEE.....*Instructor in Physiology*
A.B., Columbia, 1906; M.D., 1909.
- WYTHE M. RHETT.....*Instructor in Pharmacology*
B.S., Virginia Military Institute, 1909; M.D., Columbia, 1913.
- HENRY A. RILEY, M.D.....*Instructor in Pathology*
A.B., Yale, 1908; A.M. and M.D., Columbia, 1912.
- EMILY C. SEAMAN.....*Instructor in Physiological Chemistry, Teachers College*
B.S., Adelphi, 1899; A.M., Columbia, 1905; Ph.D., 1912.
- JAMES CLAYTON SHARP.....*Instructor in Anatomy*
M.D., Columbia, 1901.
- MAURICE J. SITTENFIELD.....*Instructor in Pathology*
M.D., Bellevue Hospital Medical College, 1898.
- FORDYCE B. ST. JOHN.....*Instructor in Anatomy*
B.S., Princeton, 1905; M.D., Columbia 1909.
- CAROLINE STACKPOLE.....*Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- ARTHUR H. TERRY, Jr.....*Instructor in Physiology*
A.B., Yale, 1906; M.D., Columbia, 1910.
- BENJAMIN T. TERRY, M.D.....*Instructor in Pathology*
A.B., Vanderbilt, 1898; A.M., 1900; M.D., Johns Hopkins, 1904.
- EUEEN VAN KLEECK.....*Instructor in Physiology*
A.B., Columbia, 1910; M.D., 1912.
- JOHN C. VAUGHAN.....*Instructor in Anatomy*
M.D., Columbia, 1907.
- MARION E. RICHARDS.....*Lecturer in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- MARY W. STEWART.....*Lecturer in Botany in Barnard College*
A.B., Columbia, 1913.
- EDGAR ALTENBURG.....*Assistant in Botany*
A.B., Columbia, 1911; A.M., 1912.
- ARNOLD K. BALLS.....*Assistant in Biological Chemistry*
B.S., Pennsylvania, 1912.
- WYNDHAM B. BLANTON.....*Assistant in Pathology*
A.B., Hampden Sidney, 1910; A.M., Virginia, 1912; M.D., Columbia, 1916.
- CHARLES L. CAMP.....*Assistant in Zoology*
A.B., California, 1915.
- JAMES L. COBB, M.D.....*Assistant in Anatomy*
A.B., Columbia, 1909; M.D., 1911.
- HELEN C. COOMBS.....*Assistant in Physiological Chemistry, Teachers College*
A.B., Columbia, 1911; B.S., 1914; M.A., 1915.
- RODERICK V. GRACE, M.D.....*Assistant in Anatomy*
A.B., College of the City of New York, 1904; M.D., Columbia, 1911.
- HATTIE L. HEFT.....*Assistant in Physiological Chemistry, Teachers College*
B.S., Louisville, 1912; M.S., 1913; M.A., Columbia, 1914.

- EDNA M. HENRY.....*Assistant in Zoology in Barnard College*
A.B., Columbia, 1915.
- HUBERT S. HOWE.....*Assistant in Pathology*
A.B., Denver, 1908; M.D., Columbia, 1912.
- JOHN D. KERNAN, JR., A.B., M.D.*Assistant in Anatomy*
A.B., Harvard, 1900; M.D., Columbia, 1913.
- SIDNEY D. KRAMER.....*Assistant in Biological Chemistry*
B.S., College of the City of New York, 1914.
- VICTOR E. LEVINE*Assistant in Biological Chemistry*
A.B., College of the City of New York, 1909; A.M., Columbia, 1911; Ph.D., 1914.
- JOSEPH LINTZ.....*Assistant in Pathology*
B.S., Columbia, 1914; M.D., 1916.
- ROBERT S. MCEWEN.....*Assistant in Zoology*
A.B., Western Reserve, 1911; A.M., 1912.
- CONSTANTINE J. MACGUIRE, JR., M.D.*Assistant in Anatomy*
A.B., Yale, 1907; M.D., Columbia, 1911.
- HENRY F. A. MEIER.....*Assistant in Botany*
A.B., Indiana, 1912; A.M., 1913.
- J. HOWARD MUELLER.....*Assistant in Pathology*
B.S., Illinois Wesleyan, 1912; M.S., Louisville, 1914.
- MAURICE A. RAINES.....*Research Assistant in Botany*
B.S., Columbia, 1915.
- HESTER M. RUSK.....*Assistant in Botany in Barnard College*
A.B., Columbia, 1912.
- MARTIN DE FOREST SMITH.....*Assistant in Anatomy*
A.B., Columbia, 1909; M.D., 1912.
- CLARA C. WARE.....*Assistant in Zoology in Barnard College*
A.B., Bryn Mawr, 1910; A.M., Columbia, 1915.
- CECIL YAMPOLSKY.....*Assistant in Botany*
B.S., Wisconsin, 1913.
- DONNELL B. YOUNG.....*Assistant in Zoology*
B.S., Amherst, 1911.

MEMBERS OF THE STAFF OF THE BOTANICAL GARDEN GIVING INSTRUCTION
IN THE DIVISION

- NATHANIEL LORD BRITTON, Ph.D., Sc.D.....*Director*
- WILLIAM ALPHONSO MURRILL, Ph.D.....*Assistant Director*
- ARLOW BURDETTE STOUT, Ph.D.....*Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D.....*Head Curator of the Museums*
- FRED. JAY SEAVER, Ph.D.....*Curator*
- PER AXEL RYBERG, Ph.D.....*Curator*
- ARTHUR HOLLICK, Ph.D.....*Curator*
- MARSHALL AVERY HOWE, Ph.D.....*Curator*
- GEORGE VALENTINE NASH.....*Curator of the Plantations*
- HENRY HURD RUSBY, M.D.....*Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D.....*Consulting Chemist*

Partial courses are also given by

- ELIZABETH GERTRUDE BRITTON.....EDWARD SANFORD BURGESS, Ph.D.

GENERAL STATEMENT

Introductory. The Division of Biology includes the departments of Anatomy, Bacteriology, Biological Chemistry (Nutrition), Botany, Pathology, Physiology, Pharmacology, and Zoology in all schools of the University.

Students in this Division are received as candidates for the degrees of Master of Arts and Doctor of Philosophy under the Faculty of Pure Science. Certain courses which may be counted toward a higher degree are also offered in the Summer Session and in Extension Teaching.

Degrees. The requirements for the higher degrees are stated in full in a bulletin entitled "Instruction for Candidates for the Degrees of Master of Arts and Doctor of Philosophy," which will be sent upon application to the Secretary of the University. This bulletin contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments and all other University matters of interest to graduate students.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those for men.

Funds and Prizes. Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy. The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology. The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media. The laboratories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

Biological Chemistry (Nutrition). At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor Gies' library occupies a room adjoining the laboratory and is accessible by appointment to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoological Park for research, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany. The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultraviolet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammeters, resistance measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus affords facilities for experimental work in physiology and pathology and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic collections are in special rooms. Ample opportunity for experimental work in

plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses.

The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

A seminar for the study of special subjects in general physiology meets weekly and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a bi-weekly colloquium.

Pathology. The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, amphitheater, photographic rooms, etc., on the fifth floor. On the fourth floor, there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a clinical laboratory, the museum, preparation rooms, cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology. The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises two laboratories, which are provided with special apparatus for teaching purposes; six laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, mainly for research; a library containing sets of the physiological journals, monographs and other books, and many reprints of special articles; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoology. The zoological laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoology, and eight rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the collections of the American Museum of Natural History (see below), the department does not maintain a general zoological museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, charts and wax models and an aquarium room.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoology and palæontology of invertebrates and vertebrates, both from the systematic and bionomic points of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoological Park in the Borough of the Bronx, under the direction of the New York Zoological Society, affords exceptional opportunities for the study of living reptiles, birds and mammals.

The New York Aquarium, also under the management of the Zoological Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets every week in the departmental library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, five investigators' rooms (ten tables) are subscribed for by the University for the use of the Department of Zoology; in the latter a table is available through the John D. Jones Scholarship. The University also maintains an investigators' table at the Naples Zoological Station.

Publications by Members of the Division. The Columbia University Press issues the *Columbia University Biological Series*, of which ten volumes have already appeared.

The Department of Physiology issues *Studies from the Department of Physiology*, of which six volumes have already appeared.

ANATOMY

Anatomy 101—Histology and Embryology. Lectures, conferences and laboratory work 12 hours. Double course. Professor SCHULTE and Drs. STRONG, SHARP, HEAGEY, VIETOR and PICKHARDT.

Anatomy 103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences and dissections 12 hours. Two full courses. Drs. BROWN, VAUGHAN, GRACE and MCGUIRE.

Anatomy 105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work and dissection 12 hours. Double course. Professor TILNEY and Drs. STRONG, ST. JOHN and COBB.

Anatomy 107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations 3 hours. Half course. Professor HUNTINGTON.

Anatomy 202—Special Morphology. 3 hours. Half course. Professors HUNTINGTON and SCHULTE.

Anatomy 204—Morphology of the Nervous System. 3 hours. Half course. Professor TILNEY.

Anatomy 251-252—Research in Anatomy. Under the direction of the professor of anatomy. The officers of the department. Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

Anatomy 302—Seminar in Histology and Embryology. 1 hour. Professor SCHULTE.

BACTERIOLOGY

Preliminary Statement

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. They should fulfill the requirements exacted of candidates for entrance to the medical school. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoology in the Department of Zoology.

Courses 201 and 203, 205-206, 208, 211-212, 251-252 are open to women.

Bacteriology 101—General Bacteriology, especially adapted to the requirements of students of medicine. 6 hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. Full course. Professors ZINSSER and HOPKINS, Dr. DWYER and Mr. BLISS.

Bacteriology 201—Advanced Bacteriology. The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon in October, November, December and January. Double course. Professors ZINSSER and HOPKINS and Dr. DWYER.

This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch d. Pathogenen Mikroorganismen*, Macé's *Bacteriologie*.

Bacteriology 203—Special Bacteriology. Rating individually determined for each case at the time of registration. Professors ZINSSER and HOPKINS.

As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; and the pursuit of some selected theme for original investigation.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology* Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*.

Attendance and hours individually arranged.

Bacteriology 205-206—The Principles of Infection, Immunity, Serum Diagnosis and Therapy. Lectures with demonstrations 1 hour. Half course. Professor ZINSSER. Text-book: Zinsser "Infection and Resistance."

Bacteriology 208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twenty students. Full course. Professors ZINSSER and HOPKINS, Dr. OTTENBERG.

Bacteriology 209-210—Clinical Bacteriology. Half course each half year. Dr. DWYER.

A course will be given at the laboratory of the Manhattan Eye, Ear and Throat Hospital in which a small group of students will be taught the methods of examining material from patients suffering from infections chiefly of the eye, ear, nose and throat, and course will include the bacteriological diagnosis of material, the making of blood cultures, the making of autogenous vaccines and their use in the treatment of patients, etc.

Bacteriology 211-212—Clinical Serology. Two full courses. Dr. OTTENBERG and Assistants.

Technique of Wassermann reaction and other clinical serum reactions. Laboratory open to properly qualified graduate students, to physicians and to undergraduates who have taken courses 205-206 and 208.

Bacteriology 251-252—Research in Bacteriology. Under the direction of the professor of bacteriology. Professor ZINSSER and Staff.

Rating individually determined at the time of registration.

Summer Session

Bacteriology s101—General Bacteriology. 2 points, equivalent to Course 101. Full course. Dr. HOPKINS and Dr. DWYER.

Course in Teachers College

For details of a course in bacteriology applied to household arts given in Teachers College by Professor BROADHURST, see the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

For details of a laboratory course of 32 hours in Bacteriology, given in the College of Pharmacy, see the separately printed *Announcement of the College of Pharmacy*.

BIOLOGICAL CHEMISTRY
(Nutrition)*Courses in Nutrition (Physiological and Pathological Chemistry)*

Biological Chemistry 101 or 102—General Physiological Chemistry. C 1 hour, L 7 hours. Full course. Professors GIES and HOWE, and Drs. HOROWITZ, LEVINE and PERLZWEIG.

A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes.

Required, in the second half of the first year, of candidates for M.D. Open as an elective to qualified Juniors and Seniors of Columbia College.

Biological Chemistry 202—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Household Arts.) C 1 hour, L 6 hours. Full course. Professor GIES and Miss HEFT.

Biological Chemistry 211-212—Biochemical Methods of Research, including Clinical Methods. C 1 hour, L 7 hours. Two full courses. Dr. MILLER and Mr. BALLS.

Biological Chemistry 214. Comparative nutrition C 2 hours. Full course. Dr. MORGULIS.

Biological Chemistry 221-222—Nutrition in Health (advanced physiological chemistry). C 2 hours, L 14 hours. Two double courses. Professor HOWE and Dr. MILLER.

Biological Chemistry 223-224—Nutrition in Disease (general pathological chemistry). C 2 hours, L 14 hours. Two double courses. Professor GIES.

Biological Chemistry 225-226—Nutrition in Disease. C 2 hours. Two half courses. Drs. GOODRIDGE, KRAUS, MORGULIS, and WEINBERGER.

Biological Chemistry 251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 20 hours. Two double courses. Professor GIES and Dr. MILLER.

Toxiological Chemistry

Biological Chemistry 261-262—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L 10 hours. Two full courses. Professor GIES and Dr. MILLER.

Botanical Chemistry

Biological Chemistry 271-272—Chemical Physiology of Plants. C 1 hour, L 7 hours. Two full courses. (The course may be taken in whole or in part at the New York Botanical Garden, where Professor Gies is consulting chemist.) See Botany, page 16. Professor GIES and Dr. HOROWITZ.

Bacteriological Chemistry

Biological Chemistry 281-282—Chemistry of Micro-organisms; Fermentations, Putrefactions, and Enzyme Actions in General (introduction to sanitary chemistry). C 1 hour, L 7 hours. Two full courses. Professor GIES and Mr. KRAMER.

Seminar

301-302—The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department, meet weekly to discuss results of recent researches in chemical biology. 1 hour. No course credit. Professor GIES.

Summer Session

For details of the work in Biological Chemistry offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University. It also issues the quarterly BIOCHEMICAL BULLETIN now in its fifth volume.

BOTANY

Graduate work in botany presupposes the possession of a general knowledge of the subject gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering upon such work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4 and 101-102 for men or Courses 51-52, 53-54, 153 and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Candidacy for a degree in the subject presupposes also the ability to commence and carry on successfully a definite line of research.

All graduate courses are open to women.

A. Undergraduate Courses

Botany 1-2—General Botany. C 2 and L 4 hours. Professor CURTIS and Mr. ALTENBURG.

Botany 3-4—Plant Morphology. C 2 and L 4 hours. Professors HARPER and CURTIS.

Botany 5—Elementary Plant Pathology. C 1, L 3 hours. Dr. DODGE.

Botany 6—Economic Botany. C 1 hour, L 3 hours. Dr. DODGE.

Botany 7—Growth and Character of Timber. C 1 hour, L 3 hours. Professor CURTIS and Mr. ALTENBURG.

Botany 9-10—Botanical Problems. Introductory to research. Professors HARPER, CURTIS and MARQUETTE.

Botany 11-12—Plant Anatomy and Histology. C 2, L 4 hours. Professor MARQUETTE.

B. Graduate Courses

Botany 101-102—Plant Physiology. C 2 hours, L 6 hours. Two full courses Professor MARQUETTE.

Botany 103-104—Structure and Development of Plants. A general survey of the plant kingdom from the standpoint of structure and phylogeny. Two full courses. Professors HARPER and CURTIS.

Botany 113-114—Morphology of the Higher Plants. Study of the orders, including the structure and relationships of plants. Two full courses. Professor CURTIS and Mr. ALTENBURG.

Botany 115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. Two full courses. Professor HARPER and Dr. DODGE.

Botany 117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. Two full courses. Professor HARPER and Dr. DODGE.

Botany 120—Plant Electrophysiology. Lectures on the production of electrical disturbances in plant tissues; reactions of plants to electrical stimulation; application to crop production. Half-course. Professor MARQUETTE.

C. Advanced Graduate and Research Courses

Hours and credit for courses in research (Botany 200 to 244) are arranged on consultation and should be recorded at the office of the Registrar.

Botany 201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. Professors RICHARDS, CURTIS and MARQUETTE.

Botany 209-210—Physiology of Nutrition. Treated from a chemical standpoint. Professors RICHARDS and GIES.

Botany 211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. Professor HARPER, Dr. MURRILL, Dr. SEAVER and Dr. DODGE.

Botany 217-218—Embryology of Spermatophyta. With special work during two summers. Professors CURTIS and HAZEN.

Botany 219-220—Morphology. Work dealing with morphological problems in the various groups of plants. Directed by members of the department and Botanical Garden staff.

Botany 227-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. Directed by members of the Botanical Garden staff.

Botany 235-236—Plant Distribution. Problems dealing with regional botany or plant geography. Professor BRITTON and other members of the staff.

Botany 239-240—Developmental Taxonomy. Fossil ancestors of some family of plants. Dr. HOLLICK.

Botany 241-242—Research on the Physiology of the Cell and Reproduction. Professor Harper.

Botany 243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. Dr. STOUT.

Botany 301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. 2 half-courses. Professor HARPER.

Colloquium—A biweekly meeting for the discussion of current botanical literature.

Conference—A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Botany 51-52—Principles of Plant Morphology and Physiology. C 2 hours, L 4 hours. Professor RICHARDS, Miss STEWART and Miss RUSK (Barnard).

Botany 53-54—General Morphology and Development of Plants. C 2 hours, L 4 hours. Professor HAZEN and Miss RUSK (Barnard).

Botany 55-56—Morphology and Classification of Spermatophytes. Study of the Natural Orders. C 1 hour, L 4 or 6 hours. Professor HAZEN.

Botany 153—Anatomy of Vascular Plants. C 2 hours and a minimum of L 6 hours. Full course. Mrs. RICHARDS (Barnard).

[**Botany 154—Physiology of Plants from Standpoint of Nutrition.** C 2 hours and a minimum of L 6 hours. Full course not given 1916-17.] Professor RICHARDS and Mrs. RICHARDS (Barnard).

Botany 156—Physiology of Plants from Standpoint of Growth. C 2 hours and a minimum of L 6 hours. Full course. Professor RICHARDS and Mrs. RICHARDS (Barnard).

Botany 158—Structure and Development of Algæ. Advanced course. C 1 hour, L 6 hours. Full course. Professor HAZEN.

Botany 159—Structure and Development of Fungi. Advanced course. C 1 hour, L 6 hours. Full course. Professor RICHARDS.

Courses 158-59 are not usually given the same year.

Botany 160—Embryology and Laboratory Methods. Practice in methods of technique, with the study of the embryology of one or more types. L 8 hours with occasional lectures and outside reading. Full course. Professor HAZEN.

Botany 161-162—Advanced Physiology and Morphology. Work will be arranged to suit the needs of the students. Half, full or double course. Professors RICHARDS and HAZEN and Mrs. RICHARDS (Barnard).

Summer Session and Extension Teaching

(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain pre-requisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors Bigelow and Broadhurst and Miss Stackpole. See Biology and Nature-Study in the current *Announcement of Teachers College*.

Courses in the College of Pharmacy

A course of 30 lectures, 30 recitation hours and 75 hours laboratory work in structural and descriptive botany; a laboratory course of 90 hours in botany applied to the study of drugs; and a course of 30 hours in plant classification are given in the College of Pharmacy.

Courses in Biometrical Methods

See page 24

PATHOLOGY

Pathology 102—General and Special Pathology. 12 hours, second half. Double course. Professors MACCALLUM and PAPPENHEIMER, Dr. LAMBERT, COULTER, MACKENZIE and others.

Pathology 106—Gross Pathological Anatomy and Attendance upon Autopsies. 4 hours, second half, and at other times as occasion offers. One half course. Professors MACCALLUM and PAPPENHEIMER and Drs. LAMBERT, MACKENZIE and others.

Pathology 107—Experimental Pathology. 3 hours; limited to twelve students. Half course. Professor MACCALLUM.

Pathology 201-202—Advanced Pathology. The officers of the department. Credit for this course varies from one half-course to one double course each half-year, according to arrangements made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Pathology 251-252—Research in Pathology. Under the direction of the professor of Pathology. The officers of the department.

Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

See also additional courses listed under George Crocker Special Research Fund on page 25.

PHARMACOLOGY

Pharmacology 213-214—General Pharmacology. Lectures, 1 hour; laboratory work, 6 hours. Two full courses. Professor LIEB and Dr. FREEMAN.

Pharmacology 215—Biological Standardization of Drugs. Laboratory work 7 hours; first half-year. Half course. Professor Lieb.

The Department of Pharmacology occupies the eastern section of the third floor of North building of the College of Physicians and Surgeons. It com-

prises a laboratory for undergraduate instruction in pharmacology and pharmacy, three research laboratories, a chemical laboratory and a well-equipped shop. The laboratories are supplied with all apparatus necessary for the investigation of pharmacological problems.

PHYSIOLOGY

Physiology 2—Elementary Physiology. C 2 hours, L 4 hours. 516 S. 3 points. Dr. SCOTT (E.L.).

Physiology 106-107—Human Physiology. Lectures 3 hours; demonstrations 1 hour; recitations 2 hours; laboratory work 3 hours. Two full courses. Professors BURTON-OPITZ and WILLIAMS (H.B.) and Drs. BISHOP, GORDON, PARDEE, TERRY and VAN KLEECK.

Physiology 108—Physics of X-Rays. Lectures with demonstrations; 1 hour; eight weeks. Professor WILLIAMS (H.B.). Half course.

Physiology 201-202—General Physiology. Lectures 1 hour; laboratory work 5 hours. Two full courses. Professor PIKE and Dr. SCOTT (E.L.).

Physiology 203-204—Special Physiology. Lectures 1 hour; laboratory work 5 hours. Two full courses. Professors BURTON-OPITZ, PIKE and WILLIAMS (H.B.) and Dr. SCOTT (E.L.).

Physiology 205-206—Problems of Evolution from the Standpoint of Physiology. Lectures 1 hour. Half course. Professor PIKE.

For graduate students 205 and 206 together will be credited as a half-course.

Physiology 207—Clinical Physiology. The application of physiological methods to the problems of clinical medicine. Lectures and demonstrations 2 hours, first half year. Professors BURTON-OPITZ, PIKE and WILLIAMS (H.B.) and Dr. WHEELWRIGHT. Full course.

Physiology 208—Principles of electrocardiography. Lectures with demonstrations; 1 hour; six weeks. Professor WILLIAMS (H.B.). Half course.

Physiology 251-252—Research in Physiology. Under the direction of Professor Lee. The officers of the department. Hours to be arranged.

Credit for this course varies from one half course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

Courses in Barnard College

A course in general Animal Physiology is given by the Department of Zoology of Barnard College, supplementing the work in general Biology and Zoology. See page 20 and the separately printed *Announcement of Barnard College*.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College: One dealing with Plant Nutrition, Botany 154, a second with Growth, Botany 156, a third with advanced problems in Physiology, Botany 161-162. Professors RICHARDS and Mrs. RICHARDS. See page 15 and the separately printed *Announcement of Barnard College*.

Summer Session

For information in regard to the courses in Physiology offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Courses in Teachers College

The Department of Physical Education of Teachers College offers Physical Education 55-56, Applied Physiology.

The courses in Applied Biology given in Teachers College are chiefly physiological. Professors Bigelow and Broadhurst and Miss Stackpole. For details consult the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

A course of 30 lectures and 30 recitations in Human Physiology is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, pp. 15 and 16. They include Courses Nos. 101 and 102, General Plant Physiology (Professor Marquette); 120, Plant Reactions (Professor Marquette); 201-208, Advanced Physiology (Professors Richards, Curtis and Marquette); Physiology of Nutrition (Professors Richards and Gies).

Journal Club

A journal club, composed of the members of the staff and graduate students, holds weekly meetings for the discussion of current literature and special investigations.

NEUROLOGY

Neurology 231-232—Psychopathology and Psychotherapy, inclusive of the Psychopathology, Psychotherapy and Mental Examinations of the Psychopathic Child. At the Vanderbilt Clinic; clinical lectures; one hour for one-half year. Half course. Dr. HABERMAN. This course may be elected for either the first or the second half-year.

ZOOLOGY

Graduate work in zoology requires at least two years of preparatory undergraduate study or the equivalent, i.e., an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses 1-4, 51, 91-92 and 93. For students whose main interest lies in other subjects less extensive preparation may suffice, but such students must have taken at least one year's work in zoology or elementary biology. Courses numbered below 100 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a sufficient standard of knowledge and training as shown particularly by the doctor's dissertation. Eight full courses, or equivalent, are required for the degree of Master of Arts, and approximately double this number are usually recommended for the degree of Doctor of Philosophy. In either case specially assigned study or research (to be registered as Course 227-228) may in part take the place of formal course-work. To Ph.D. students whose main work is in Zoology Courses 201, 215-216, 221-222, 223-224 and 225-226 are suggested as a general foundation.

All the graduate courses are open to women.

A. Undergraduate Courses

Zoology 1-2—Elementary Biology (Zoology). C 2 hours, L 4 hours. Professors CALKINS and MCGREGOR, Dr. PACKARD (Columbia College); Professor CRAMPTON, Dr. DEDERER, Dr. L. H. GREGORY (Barnard College).

Zoology 3—Elementary Histology. 1 hour. Dr. DEDERER (Barnard College).

Zoology 4—Elementary Embryology. C 1 hour, L 2 hours. Professor MORGAN (Columbia College); Professor CRAMPTON (Barnard College).

Zoology 5—General Biology. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

Pre-requisite: *Zoology 1-2*.

Zoology 6—Experimental Biology. An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

Zoology 7-8—Biology and Genetic Relations of the Human Organism. General anatomy and physiology of the human type in comparison with other organisms; the biological basis of individual hygiene, of human genetics and social relations. W. and F. at 3. 4 points. Professor CRAMPTON and Dr. GREGORY (Barnard College).

Open to students of all classes. Students who have previously taken *Zoology 1-2* will receive only 2 points credit. This course does not count as fulfilling the prescribed requirement in science for the A.B. or B.S. degree.

Zoology 9—Theories of Modern Biology. Open to qualified students of Columbia College. Lectures and discussions. Tuesday and Thursday at 2. 2 points. Professor CALKINS.

Pre-requisite: *Zoology 1*, except by special permission of the instructor.

Zoology 51—Histology and Technique. The preparation and study of animal tissues. C 1, L 4 hours. Dr. PACKARD.

Zoology 53-54—Practical Zoology and Embryology. 2 points. Dr. DEDERER (Barnard College).

Zoology 91-92—General Zoology. C 2 hours, L 6 hours. Professor MCGREGOR (Columbia College).

Zoology 93—Comparative Embryology of Vertebrates. C 1 hour, L 2 hours. Professor MCGREGOR (Columbia College).

Zoology 95-96—Comparative Morphology of Vertebrates. C 1 hour, L 4 hours. Professor MCGREGOR.

Pre-requisite: *Zoology 1-2*.

B. Graduate Courses

Zoology 101-102—General Zoology. 2 full courses. Professor MCGREGOR (Columbia College); Professor CRAMPTON, Dr. DEDERER, Dr. L. H. GREGORY (Barnard College).

This course covers the same general ground as *Zoology 91-92*, but is supplemented by additional assigned work.

Zoology 103—Comparative Embryology of Vertebrates. Half course. Professor MCGREGOR.

Covers the same ground as *Zoology 93*, with additional assigned work.

Zoology 105-106—Comparative Morphology of Vertebrates. Two half courses. Professor MCGREGOR.

Covers the same ground as *Zoology 95-96*, with additional assigned work.

Zoology 110—The Parasitic Protozoa. Full course. Professor CALKINS.

A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had *Zoology 91* or its equivalent.

Zoology 113—Tropisms. One day a week. Full course. Professor MORGAN.

This course deals with the simpler responses of organisms to external factors and serves as an introduction to the next course, *Zoology 114*.

Pre-requisite: *Zoology 1-2, 91-92*.

Zoology 114—Instincts. An analysis of the more complex behavior of animals and the problems of the evolution of instincts. One day a week. Full course. Professor MORGAN.

Pre-requisite: *Zoology 1-2, 91-92*.

Zoology 151-152—General Physiology. General principles of human and animal physiology. C 2 hours, L 4 hours. Dr. L. H. GREGORY (Barnard College). 2 full courses.

C. Advanced Graduate Courses

General Zoology

The two following courses are designed to complete the work in general zoology begun in *Zoology 1-2* and continued in *Zoology 91-92*. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

Zoology 201—Topics in Invertebrate Zoology, with Especial Reference to Problems of Phylogeny. 2 days a week. Double course. Professor WILSON.

Zoology 223-224—Evolution of the Vertebrates. I (223), Fishes Recent and Fossil. II (224) Amphibia and Reptiles; Origin of the Birds; Origin of the Mammals. Systematic, phylogenetic and morphological studies. Evolution of the head and locomotive apparatus of vertebrates. One day a week, at the American Museum. 2 full courses. Dr. W. K. GREGORY.

The material studied comprises over 700 specimens of recent and fossil types.

Embryology and Cellular Biology

Zoology 208—General Embryology of Invertebrate Types. Seminar. Lectures, special reading, and laboratory work. 1 day a week. Full course. Professor CALKINS.

Zoology 220—Cellular Embryology (see also 218 and 225-6). Full course. Professor WILSON.

A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. One lecture a week and assigned work. *Zoology 93* and *Zoology 208* form a desirable preparation. This and *Zoology 218* are parallel courses which supplement each other.

Zoology 225-226—Cellular Biology. General structure and functions of the cell. 2 full courses. Professor WILSON.

Morphology and Evolution of Special Groups

Zoology 203-204—Mammals, Living and Fossil. 10 hours, lecture and laboratory. 2 full courses. Dr. W. K. GREGORY.

Structure, origin and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum.

Protozoology

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life histories to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Parasitic Protozoa (see page 22).

Zoology 221-222—Protozoology. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology and physiology. 2 full courses. Professor CALKINS.

Zoology 230—Experimental Protozoology. Full course.

The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization and age. Individual research problems for registered students.

Pre-requisite: 221.

Experimental Zoology

The following courses (215-218 with 113-114) cover three years' work, each including one day a week. Each course may be taken independently of the others and not necessarily in the order given.

Zoology 215-216—Experimental Zoology. Two lectures a week, with laboratory work on special problems. 2 double courses. Professor MORGAN.

Approximately half of the year is given to Mendelian heredity and genetics; the other half to the influence of the environment in modifying organisms and in affecting their modes of reproduction (sex determination).

Zoology 217—Physiological Morphology. One lecture a week. Special research. Full course. Professor MORGAN.

A discussion of theories dealing with the relation of function and structure as illustrated by growth, regeneration, transplantation and tissue culture.

Zoology 218—Experimental Embryology. The rôle of external factors in normal development. This course is parallel to 220, which treats of internal factors. One lecture a week. Special research. Full course. Professor MORGAN.

Special Research

Zoology 227-228—Investigation of special problems in any of the subjects enumerated above, counting as half, full, or double course.

Courses in Biometrical Methods

Anthropology 121—Anthropometry—Biometrical Methods. C 2 hours. Full course. Professor BOAS.

This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the inter-relations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged.

Anthropology 122—Anthropometry—Growth. C 2 hours. Full course. Professor BOAS.

A discussion of the phenomena of growth with special relation to the influences of heredity and of environment.

Courses Under The George Crocker Special Research Fund

Zoology 209—Morphology and Classification of Tumors, including Pathological Technique. One full course. Professor WOOD.

Pre-requisite: Mammalian histology.

Zoology 202—General Biology of Tumors. One full course. Professor WOGLOM.

Pre-requisite: Mammalian histology.

Zoology 205-206—Research in Problems of Growth Pathology with Especial Reference to Tumors. Credit to be assigned in individual cases at the time of registration. Professors WOOD and WOGLOM and Drs. PRIME and BULLOCK.

The laboratories of the George Crocker Special Research Fund are open to properly qualified workers for research in pathology under the supervision of the Director of Cancer Research.

Course in the College of Pharmacy

A laboratory course of 200 hours in the general biology of plants and animals is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

Courses in the College of Physicians and Surgeons

Zoology 101—Histology and Embryology. 12 hours. Double course.

Professors SCHULTE and MILLER and Drs. STRONG and SHARP.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to Seniors and graduates who have completed certain pre-requisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors Bigelow and Broadhurst and Miss Stackpole. See Biology and Nature-Study in the current *Announcement of Teachers College, School of Education*.

ACADEMIC CALENDAR

1916-1917

June 19, Monday. Entrance examinations begin.

July 10, Monday. **Seventeenth Summer Session begins.**

Aug. 18, Friday. **Seventeenth Summer Session ends.**

Aug. 31, Thursday. Last day for filing applications for admission on advanced standing or as non-matriculants.

Sept. 11, Monday. Last day for filing applications for entrance, advanced standing and deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.

Sept. 18, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.

Sept. 20, Wednesday. **Registration** (including the payment of fees) **begins.**

Sept. 26, Tuesday. Registration ceases for students previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.

Sept. 27, Wednesday. **Winter Session 1916-17 begins.**
Registration ceases for students not previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.
Fellows and Scholars to report to the Registrar.

Sept. 29, Friday. French and German Reading Tests.

Oct. 17, Tuesday. Stated meeting of University Council.

Nov. 7, Tuesday. Election Day, holiday.

Nov. 29, Wednesday. **Annual Thanksgiving Service** in St. Paul's Chapel.

Nov. 30, Thursday, to December 2, Saturday, inclusive, Thanksgiving holidays.

Dec. 10, Sunday. **Annual Commemoration Service** in St. Paul's Chapel.

Dec. 19, Tuesday. Stated meeting of University Council.

Dec. 20, Wednesday, to

1917

Jan. 2, Tuesday, inclusive, Christmas holidays.

Jan. 11, Thursday. Last day for filing applications for entrance examinations. The privilege of later application may be granted on payment of a fee of \$5.

Jan. 18, Thursday. Mid-year entrance examinations begin.

Jan. 24, Wednesday. Mid-year examination begin.

Feb. 5, Monday. **Registration** (including the payment of fees) **begins.**

Feb. 6, Tuesday. Winter Session ends.

Feb. 7, Wednesday. **Spring Session begins** University Service in St. Paul's Chapel.
Registration ceases for students entering Spring Session.

Feb. 12, Monday. Alumni Day.

Feb. 20, Tuesday. Stated meeting of University Council.

Feb. 22, Thursday. Washington's Birthday holiday.

Mar. 1, Thursday. Last day for filing applications for University Fellowships and Scholarships.

Apr. 5, Thursday, to April 9, Monday, inclusive, Easter holidays.

Apr. 17, Tuesday. Stated meeting of University Council.

Apr. 18, Wednesday. Last day for filing applications for all degrees to be conferred in June, except Master of Arts and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.

Apr. 23, Monday. Last day for filing applications for deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.

May 1, Tuesday. Last day for students in the School of Journalism to file changes in program of studies for following year. The privilege of filing such changes later may be granted on payment of a fee of \$5.

- May 21, Monday. Final examinations begin.
- May 30, Wednesday. Memorial Day, holiday.
- June 3, Sunday. **Baccalaureate Service.**
- June 4, Monday. Class Day.
- June 6, Wednesday. **Commencement Day.**
- June 13, Wednesday. Spring Session ends.
- June 18, Monday. Entrance examinations begin.
- July 9, Monday. Eighteenth **Summer Session begins.**
- Aug. 17, Friday. Eighteenth Summer Session ends.
- Sept. 10, Monday. Last day for filing applications for entrance, advanced standing and deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 17, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.
- Sept. 19, Wednesday. **Registration** (including the payment of fees) **begins.**
- Sept. 25, Tuesday. Registration ceases for students previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 26, Wednesday. **Winter Session 164th year begins.** Registration ceases for students not previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5. Fellows and Scholars to report to the Registrar.
- Sept. 28, Friday. French and German reading tests.

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1917/18

seventeenth Series, No. 32

July 14, 1917



Columbia University Bulletin of Information

DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PATHOLOGY, PHARMA-
COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT
1917-1918

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[Issued 32 times during the academic year, monthly in November, and weekly between December and June. Entered as second-class matter at the New York, N. Y., Post Office, Dec. 22, 1900, under Act of July 16, 1894.] These include:

1. Annual Reports of the President and Treasurer to the Trustees.

2. The Catalogue of the University, price 25 cents, and the Announcements of the several Colleges and Schools, and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University.

U.P.O. 3,000-1917.

OFFICERS OF THE DIVISION OF BIOLOGY

- GEORGE S. HUNTINGTON *Professor of Anatomy, Executive officer,
Department of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D., Jefferson
Medical College, 1907.
- HENRY FAIRFIELD OSBORN *Research Professor of Zoology*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901; Princeton, 1902;
Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.) Christiania, 1911; Member of
National Academy of Sciences.
- EDMUND B. WILSON *Da Costa Professor of Zoology, Executive
officer, Department of Zoology*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902; LL.D.,
Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.) Leipsic, 1909; Member of National
Academy of Sciences.
- FREDERIC S. LEE *Dalton Professor of Physiology, Executive
officer, Department of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN *Professor of Vertebrate Zoology*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D., 1890; Che-
valier de la Légion d'Honneur, 1910.
- HENRY E. CRAMPTON *Professor of Zoology*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES *Professor of Biological Chemistry, Executive
officer, Department of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Sc.D., 1914; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS . . . *Professor of Botany and Secretary of the Division*
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS *Professor of Protozoology*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.
- MAURICE A. BIGELOW *Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- RUSSELL BURTON-OPITZ *Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN *Professor of Experimental Zoology*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; LL.D., 1915; Member
of National Academy of Sciences.
- BERN B. GALLAUDET *Assistant Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.
- JOHN HENRY LARKIN *Assistant Professor of Pathology*
A.B., Manhattan, 1891; M.D., Columbia, 1894.
- JAMES HOWARD MCGREGOR *Associate Professor of Zoology*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- CARLTON CLARENCE CURTIS *Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.

- TRACY E. HAZEN *Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- ROBERT A. HARPER *Torrey Professor of Botany, Executive
officer, Department of Botany*
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of
Sciences.
- WILLIAM G. MARQUETTE *Associate Professor of Botany*
Ph.G., Northwestern, 1899; B.S., Wisconsin, 1903; Ph.D., 1907.
- FRANK HENRY PIKE *Associate Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- CHARLES C. LIEB *Assistant Professor of Pharmacology, Executive
officer, Department of Pharmacology*
A.B., Columbia, 1902; M.D., 1906.
- HANS ZINSSER *Professor of Bacteriology, Executive
officer, Department of Bacteriology*
A.B., Columbia, 1899; A.M. and M.D., 1903.
- ALWIN M. PAPPENHEIMER *Assistant Professor of Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY *Professor of Neurology*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- JEAN BROADHURST *Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908; Ph.D., Cornell, 1914.
- HORATIO B. WILLIAMS *Assistant Professor of Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- WILLIAM K. GREGORY *Assistant Professor of
Vertebrate Palæontology*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- LOUISE HOYT GREGORY *Assistant Professor of Zoology
in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- THERA DANTSCHAKOFF *Assistant Professor of Anatomy*
M.D., Lausanne, 1902; M.D., Charkow, 1903; Petrograd Academy of Medicine, 1907.
- FREDERIC G. GOODRIDGE *Associate in Biological Chemistry*
A.B., Harvard, 1897; M.D., Columbia, 1901; Ph.D., 1915.
- BENJAMIN HOROWITZ *Associate in Biological Chemistry*
Chemist, Columbia, 1911; A.M., 1912; Ph.D., 1913.
- ROBERT A. LAMBERT *Associate in Pathology*
M.D., Tulane, 1907.
- GEORGE M. MACKENZIE *Associate in Pathology*
A.B., Columbia, 1907; M.D., 1913.
- EDGAR G. MILLER, JR. *Associate in Biological Chemistry*
B.S., Gettysburg, 1911; Ph.D., Columbia, 1913.
- ERNEST L. SCOTT *Associate in Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911; Ph.D., Columbia, 1914.
- JAMES CLAYTON SHARP *Associate in Anatomy*
M.D., Columbia, 1901.
- JOSEPH S. WHEELWRIGHT *Associate in Physiology*
A.B., Yale, 1897; M.D., Cornell, 1900.

- GEORGE N. ACKER *Instructor in Pharmacology and
Assistant in Pathology*
B.S., Pennsylvania, 1909; M.D., Columbia, 1914.
- ARNOLD K. BALLS *Instructor in Bacteriology*
B.S., Pennsylvania, 1912; Ph.D., Columbia, 1917.
- FRANK WARNER BISHOP *Instructor in Physiology*
B.S., Columbia, 1910; M.D., 1912.
- ALFRED J. BROWN *Instructor in Anatomy*
A.B., Yale, 1899; M.D., Columbia, 1903.
- WILLIAM W. COX *Instructor in Physiology*
M.D., Bellevue, Hospital Medical College, 1914.
- CONDUCT W. CUTLER, JR. *Instructor in Physiology*
B.S., Columbia, 1910; M.D., 1912.
- PAULINE H. DEDERER *Instructor in Zoology in Barnard College*
A.B., Columbia, 1901; A.M., 1907; Ph.D., 1915.
- BERNARD O. DODGE *Instructor in Botany*
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- JAMES G. DWYER *Instructor in Bacteriology*
M.D., Queen's, 1905.
- J. VICTOR HABERMAN *Instructor in Psycho-Therapy*
A.B., Columbia, 1903; M.D., 1905.
- HATTIE L. HEFT *Instructor in Physiological Chemistry,
Teachers College*
B.S., Louisville, 1912; M.S., 1913; A.M., Columbia, 1914; Ph.D., 1917.
- BENJAMIN S. KLINE, M.D. *Instructor in Pathology*
A.B., Swarthmore, 1907; M.D., Johns Hopkins, 1911.
- OTTO H. LEBER *Instructor in Physiology*
A.B., Columbia, 1904; M.D., 1908.
- MALCOLM MCBURNEY *Instructor in Bacteriology*
A.B., Harvard, 1906; M.D., Columbia, 1910.
- ALEXANDER T. MARTIN *Instructor in Pharmacology*
B.S., Princeton, 1909; M.D., Pennsylvania, 1913.
- REUBEN OTTENBERG, M.D. *Instructor in Bacteriology*
A.B., Columbia, 1902; M.D., 1905.
- CHARLES PACKARD *Instructor in Zoology*
B.S., Syracuse, 1907; M.S., 1908; Ph.D., Columbia, 1914.
- EMILY C. SEAMAN *Instructor in Physiological Chemistry, Teachers College*
B.S., Adelphi, 1899; A.M., Columbia, 1905; Ph.D., 1912.
- MAURICE J. SITTENFIELD *Instructor in Pathology*
M.D., Bellevue Hospital Medical College, 1898.
- FORDYCE B. ST. JOHN *Instructor in Anatomy*
B.S., Princeton, 1905; M.D., Columbia 1909.
- CAROLINE STACKPOLE *Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- BENJAMIN T. TERRY, M.D. *Instructor in Pathology*
A.B., Vanderbilt, 1898; A.M., 1900; M.D., Johns Hopkins, 1904.
- CLARENCE P. THOMAS *Instructor in Pathology*
A.B., Yale, 1911; M.D., Columbia, 1915.

- EDGAR TSEN *Instructor in Bacteriology*
M.D., St. John's, Shanghai; M.D., Harvard Medical School in China.
- EUEN VAN KLEECK *Instructor in Physiology*
A.B., Columbia, 1910; M.D., 1912.
- JOHN C. VAUGHAN *Instructor in Anatomy*
M.D., Columbia, 1907.
- HERBERT N. VERMILYE *Instructor in Pathology*
M.D., Columbia, 1914.
- FLORENCE DE L. LOWTHER *Lecturer in Zoology in Barnard College*
A.B., Columbia, 1912; A.M., 1915.
- MARION E. RICHARDS *Lecturer in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- MARY W. STEWART *Lecturer in Botany in Barnard College*
A.B., Columbia, 1913; A.M., 1915.
- ERNST P. BOAS *Assistant in Pathology*
B.S., Columbia, 1910; M.D., 1914.
- CHARLES L. CAMP *Assistant in Zoology*
A.B., California, 1915; A.M., Columbia, 1916.
- JAMES L. COBB, M.D. *Assistant in Anatomy*
A.B., Columbia, 1909; M.D., 1911.
- SAMUEL C. DELLINGER *Assistant in Zoology*
A.B., Trinity (N. C.), 1915.
- WILFRED S. DENNIS *Assistant in Pathology*
M.D., Jefferson Medical College, 1915.
- RODERICK V. GRACE, M.D. *Assistant in Anatomy*
A.B., College of the City of New York, 1904; M.D., Columbia, 1911.
- EDNA M. HENRY *Assistant in Zoology in Barnard College*
A.B., Columbia, 1915.
- JOHN D. KERNAN, JR., A.B., M.D. *Assistant in Anatomy*
A.B., Harvard, 1900; M.D., Columbia, 1913.
- SIDNEY D. KRAMER *Assistant in Biological Chemistry*
B.S., College of the City of New York, 1914.
- ROBERT S. McEWEN *Assistant in Zoology*
A.B., Western Reserve, 1911; A.M., 1912.
- CONSTANTINE J. MACGUIRE, JR., M.D. *Assistant in Anatomy*
A.B., Yale, 1907; M.D., Columbia, 1911.
- ERNEST L. NIXON *Assistant in Botany*
B.S., Ohio, 1912; M.S., 1915.
- MERRIL V. REED *Assistant in Botany*
A.B., Nebraska, 1914; B.S., 1915.
- CHARLES H. RICHARDSON *Assistant in Biological Chemistry*
A.B., Stanford, 1912; M.S., Harvard, 1913.
- HESTER M. RUSK *Assistant in Botany in Barnard College*
A.B., Columbia, 1912.
- AURA E. LEVERINGHAUS *Assistant in Zoology*
- ADELAIDE SPOHN *Research Assistant in Physiology*
B.S., Chicago, 1908; M.S., 1913.

- MARTIN DEFOREST SMITH *Assistant in Anatomy*
A.B., Columbia, 1909; M.D., 1912.
- FENTON TAYLOR *Assistant in Anatomy*
A.B., Harvard, 1910; M.D., Columbia, 1913.
- CLARA C. WARE *Assistant in Zoology in Barnard College*
A.B., Bryn Mawr, 1910; A.M., Columbia, 1915.
- RANDOLPH WEST *Assistant in Pathology*
A.B., Princeton, 1912; A.M., 1913; M.D., Columbia, 1917.
- M. LESTER WITHERUP *Assistant in Botany*
B.S., Allegheny, 1916.

MEMBERS OF THE STAFF OF THE BOTANICAL GARDEN GIVING INSTRUCTION
IN THE DIVISION

- NATHANIEL LORD BRITTON, Ph.D., Sc.D. *Director*
- WILLIAM ALPHONSO MURRILL, Ph.D. *Assistant Director*
- ARLOW BURDETTE STOUT, Ph.D. *Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D. *Head Curator of the Museums*
- FRED. JAY SEAVER, Ph.D. *Curator*
- PER AXEL RYBERG, Ph.D. *Curator*
- ARTHUR HOLLICK, Ph.D. *Curator*
- MARSHALL AVERY HOWE, Ph.D. *Curator*
- GEORGE VALENTINE NASH *Curator of the Plantations*
- HENRY HURD RUSBY, M.D. *Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D. *Consulting Chemist*

Partial courses are also given by

- ELIZABETH GERTRUDE BRITTON EDWARD SANFORD BURGESS, Ph.D.

GENERAL STATEMENT

The Division of Biology includes the following departments: Anatomy, Bacteriology, Biological Chemistry, Botany, Pathology, Pharmacology, Physiology and Zoology, which offer courses of study leading to university degrees. This bulletin is designed primarily for advanced students and for candidates for the degrees of Master of Arts and Doctor of Philosophy. Other students should consult the announcements of Columbia College, Barnard College, Extension Teaching, College of Physicians and Surgeons, Teachers College, School of Education and Practical Arts, which may be had from the Secretary of the University.

The University requirements for the degrees of Master of Arts and Doctor of Philosophy are stated in full in the Announcement of the Faculties of Political Science, Philosophy and Pure Science, which will be sent upon application to the Secretary of the University. This Announcement contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments, university and tuition fees, and all other university matters of interest to advanced students. Special departmental requirements for the degrees of Master of Arts and Doctor of Philosophy are stated under the separate departmental headings.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those for men.

Funds and Prizes. Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy. The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology. The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media. The laborato-

ries are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

Biological Chemistry (Nutrition). At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor GIES' library occupies a room adjoining the laboratory and is accessible by appointment to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoological Park for research, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany. The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultraviolet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammeters, resistance measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus, affords facilities for experimental work in physiology and pathology, and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University, the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic collections are in special rooms. Ample opportunity for experimental work in

plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses.

The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

A seminar for the study of special subjects in general physiology meets weekly, and a botanical conference meets monthly where members of the staff and student present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a bi-weekly colloquium.

Pathology. The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, amphitheater, photographic rooms, etc., on the fifth floor. On the fourth floor, there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a clinical laboratory, the museum, preparation rooms, cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology. The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises two laboratories, which are provided with special apparatus for teaching purposes; six laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, mainly for research; a library containing sets of the physiological journals, monographs and other books, and many reprints of special articles; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoology. The zoological laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoology, and eight rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes and other apparatus for advanced work.

Owing to the accessibility of the collections of the American Museum of Natural History (see below), the department does not maintain a general zoological

museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, charts and wax models and an aquarium room.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoology and palæontology of invertebrates and vertebrates, both from the systematic and bionomic points of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoological Park in the Borough of the Bronx, under the direction of the New York Zoological Society, affords exceptional opportunities for the study of living reptiles, birds and mammals.

The New York Aquarium, also under the management of the Zoological Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets every week in the department library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

The Marine Biological Laboratories at Woods Hole, Mass., and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, five investigators' rooms (ten tables) are subscribed for by the University for the use of the Department of Zoology; in the latter, a table is available through the John D. Jones Scholarship. The University also maintains an investigators' table at the Naples Zoological Station.

Publications by Members of the Division. The Columbia University Press issues the *Columbia University Biological Series*, of which ten volumes have already appeared.

The Department of Physiology issues *Studies from the Department of Physiology*, of which six volumes have already appeared.

ANATOMY

Anatomy 101—Histology and Embryology. Lectures, conferences and laboratory work 12 hours. 8 points. Professor SCHULTE and Drs. STRONG, SHARP, HEAGEY, VIETOR and PICKHARDT.

Anatomy 103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences and dissections 12 hours. 8 points each session. Drs. BROWN, VAUGHAN, GRACE and MCGUIRE.

Anatomy 105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work and dissection 12 hours. 6 points. Professor TILNEY and Drs. STRONG, ST. JOHN and COBB.

Anatomy 107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations 3 hours. 3 points. Professor HUNTINGTON.

Anatomy 202—Special Morphology. 3 hours. 3 points. Professors HUNTINGTON and SCHULTE.

Anatomy 204—Morphology of the Nervous System. 3 hours. 3 points. Professor TILNEY.

Anatomy 251-252—Research in Anatomy. Under the direction of the professor of anatomy. The officers of the department. Credit for this course varies from 2 to 8 points each session, according to the arrangement made at the time of registration by the student with the instructor.

Anatomy 302—Seminar in Histology and Embryology. 1 hour. 1½ points. Professor SCHULTE.

BACTERIOLOGY

Preliminary Statement

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. They should fulfil the requirements exacted of candidates for entrance to the medical school. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoology in the Department of Zoology.

For the degree of Master of Arts the student must include among the courses he elects courses 201, 205, 206 and 208. An essay based on work of a research nature or a critical review is also required.

For admission to candidacy for the Ph.D. degree, the student must be able to read French and German, must have done the work in courses 201, 205, 206 and

208 and must be recommended by the department as able to undertake research.

Courses 201 and 203, 205-206, 208, 211-212, 251-252 are open to women.

Bacteriology 101—General Bacteriology, especially adapted to the requirements of students of medicine. 6 hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. 5-6 points. Professors ZINSSER and HOPKINS, Dr. DWYER and Mr. BLISS.

Bacteriology 201—Advanced Bacteriology. The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon, in October, November, December and January. 9 points. Professors ZINSSER and HOPKINS and Dr. DWYER.

This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants and of germicides.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch d. Pathogenen Mikroorganismen*, Macé's *Bacteriologie*.

Bacteriology 203—Special Bacteriology. Rating individually determined for each case at the time of registration. 6 to 18 hours laboratory. 3-9 points. Professors ZINSSER and HOPKINS.

As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; and the pursuit of some selected theme for original investigation.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*.

Attendance and hours individually arranged.

Bacteriology 205-206—The Principles of Infection, Immunity, Serum Diagnosis and Therapy. Lectures with demonstrations 1 hour. 1½ points each session. Professor ZINSSER.

Text-book: Zinsser's *Infection and Resistance*.

Bacteriology 208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twenty students. 6 points. Professors ZINSSER and HOPKINS, Dr. OTTENBERG.

Prerequisites: *Bacteriology 201 and 205*.

Bacteriology 209-210—Clinical Bacteriology. Dr. DWYER. Rating individually determined at time of registration.

A course will be given at the laboratory of the Manhattan Eye, Ear and Throat Hospital in which a small group of students will be taught the methods of examining material from patients suffering from infections chiefly of the eye, ear, nose and throat, and course will include the bacteriological diagnosis of material, the making of blood cultures, the making of autogenous vaccines and their use in the treatment of patients, etc.

Bacteriology 211 or 212—Clinical Serology. 3 points. Dr. OTTENBERG and Assistants.

Technique of Wassermann reaction and other clinical serum reactions. Laboratory open to properly qualified graduate students, to physicians and to undergraduates who have taken courses 205-206 and 208 or equivalent

Bacteriology 251-252—Research in Bacteriology. 2 to 8 points each session Under the direction of the professor of bacteriology. Professor ZINSSER and Staff.
Rating individually determined at the time of registration.

Summer Session

Bacteriology s101—General Bacteriology. 5 or 6 points, equivalent to Course 101. Dr. HOPKINS and Dr. DWYER.

Course in Teachers College

For details of a course in bacteriology applied to household arts given in Teachers College by Professor BROADHURST, see the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

For details of a laboratory course of 32 hours in Bacteriology, given in the College of Pharmacy, see the separately printed *Announcement of the College of Pharmacy*.

BIOLOGICAL CHEMISTRY
(Nutrition)

Courses in Nutrition (Physiological and Pathological Chemistry)

Biological Chemistry 101 or 102—General Physiological Chemistry. C 1 hour, L 7 hours. 5 points. Professors GIES and HOWE, and Drs. HOROWITZ, LEVINE and PERLZWEIG.

A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes.

Required, in the second half of the first year, of candidates for M.D. Open as an elective to qualified Juniors and Seniors of Columbia College.

Biological Chemistry 202—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Practical Arts.) C 1 hour, L 6 hours. 4 points. Professor GIES and Dr. HEFT.

Biological Chemistry 211-212—Biochemical Methods of Research, including Clinical Methods. C 1 hour, L 7 hours. 5 points each session. Dr. MILLER and Dr. BALLS.

Biological Chemistry 214—Comparative nutrition. C 2 hours. 3 points. Dr. MORGULIS.

Biological Chemistry 221-222—Nutrition in Health (advanced physiological chemistry). C 2 hours, L 14 hours. 8 points each session. Professor HOWE and Dr. MILLER.

Biological Chemistry 223-224—Nutrition in Disease (general pathological chemistry). C 2 hours, L 14 hours. 8 points each session. Professor GIES.

Biological Chemistry 225-226—Nutrition in Disease. C 2 hours. 3 points each session. Drs. GOODRIDGE, KRAUS, MORGULIS and WEINBERGER.

Biological Chemistry 251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 20 hours. 8 points each session. Professor GIES and Dr. MILLER.

Toxicological Chemistry

Biological Chemistry 261-262—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L 10 hours. 5 points each session. Professor GIES and Dr. MILLER.

Botanical Chemistry

Biological Chemistry 271-272—Chemical Physiology of Plants. C 1 hour, L 7 hours. 5 points each session. (The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is consulting chemist.) See Botany, below. Professor GIES and Dr. HOROWITZ.

Bacteriological Chemistry

Biological Chemistry 281-282—Chemistry of Micro-organisms; Fermentations, Putrefactions, Enzyme Actions in General (introduction to sanitary chemistry). C 1 hour, L 7 hours. 5 points each session. Professor GIES and Mr. KRAMER.

Seminar

301-302—The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department, meet weekly to discuss results of recent researches in chemical biology. 1 hour. No course credit. Professor GIES.

Summer Session

For details of the work in Biological Chemistry offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University. It also issues the quarterly BIOCHEMICAL BULLETIN now in its fifth volume.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4 and 101-102 for men or Courses 51-52, 53-54, 153 and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the com-

pletion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

All graduate courses are open to women.

For the degree of Master of Arts the Department of Botany requires that the candidate shall complete, first, a specified number of formal courses with examinations and, second, the investigation of an assigned problem with a written report on the work done.

Matriculated candidates for the degree of Doctor of Philosophy are required by the department to have as a preliminary a reading knowledge of French and German.

In addition to the thesis embodying the results of research and the courses required for the major subject, the candidate is required to complete research work or a specified number of courses in two minor subjects, one of which must be chosen outside the department. The departmental recommendation for the degree is based on the major and minor work, the completion of the thesis and the final examination.

The proportionate amount of time to be devoted to course-work and research and the choice of the courses and the problem will be determined on consultation with the member of the staff with whom the research work is to be done.

A. Undergraduate Courses

Botany 1-2—General Botany. C 2 hours, L 4 hours. Professor CURTIS and Mr. NIXON.

Botany 3-4—Plant Morphology. C 2 hours, L 4 hours. Professor CURTIS and Dr. DODGE.

Botany 5—Elementary Plant Pathology. C 1 hour, L 3 hours. Dr. DODGE.

Botany 6—Economic Botany. C 1 hour, L 3 hours. Dr. DODGE.

Botany 7—Growth and Character of Timber. C 1 hour, L 3 hours. Professor CURTIS and Mr. NIXON.

Botany 9-10—Botanical Problems. Introductory to research. Professors HARPER, CURTIS and MARQUETTE.

Botany 11-12—Plant Anatomy and Histology. C 2 hours, L 4 hours. Professor MARQUETTE.

B. Graduate Courses

Botany 101-102—Plant Physiology. C 2 hours, L 6 hours. 4 points each session. Professor MARQUETTE.

Botany 103-104—Structure and Development of Plants. A general survey of the plant kingdom from the standpoint of structure and phylogeny. 3 or 5 points each session. Professor CURTIS and Dr. DODGE.

Botany 113-114—Morphology of the Higher Plants. Study of the orders, including the structure and relationships of plants. 3 or 5 points each session. Professor CURTIS and Mr. NIXON.

Botany 115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Botany 117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Botany 120—Plant Electro-physiology. Lectures on the production of electrical disturbances in plant tissues; reactions of plants to electrical stimulation; application to crop production. 3 points. Professor MARQUETTE.

Botany 121-122—Advanced Morphology. Bryophyta and Pteridophyta. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Prerequisite: *Botany 103-104*

C. Advanced Graduate and Research Courses

Hours and credit for courses in research (Botany 200 to 244) are arranged on consultation and should be recorded at the office of the Registrar.

Botany 201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. 4 or 8 points each session. Professors RICHARDS, CURTIS and MARQUETTE.

Botany 209-210—Physiology of Nutrition. Treated from a chemical standpoint. 4 or 8 points each session. Professors RICHARDS and GIES.

Botany 211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. 4 or 8 points each session. Professor HARPER and Drs. MURRILL, SEAVER and DODGE.

Botany 217-218—Embryology of Spermatophyta. With special work during two summers. 4 or 8 points each session. Professors CURTIS and HAZEN.

Botany 219-220—Morphology. Work dealing with morphological problems in the various groups of plants. 4 or 8 points each session. Directed by members of the department and Botanical Garden staff.

Botany 227-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. 4 or 8 points each session. Directed by members of the Botanical Garden staff.

Botany 235-236—Plant Distribution. Problems dealing with regional botany or plant geography. 4 or 8 points each session. Professor BRITTON and other members of the staff.

Botany 241-242—Research on the Physiology of the Cell and Reproduction. 4 or 8 points each session. Professor HARPER.

Botany 243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. 4 or 8 points each session. Dr. STOUT.

Botany 301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. 2 points each session. Professor HARPER.

Botany 303-304—Seminar for the study of problems in plant physiology. 2 points each session. Professor MARQUETTE.

Colloquium—A biweekly meeting for the discussion of current botanical literature.

Conference—A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Botany 51-52—Principles of Plant Morphology and Physiology. C 2 hours, L 4 hours. Professor RICHARDS, Miss STEWART and Miss RUSK (Barnard).

Botany 53-54—General Morphology and Development of Plants. C 2 hours, L 4 hours. Professor HAZEN and Miss RUSK (Barnard).

Botany 55-56—Morphology and Classification of Spermatophytes. Study of the Natural Orders. C 1 hour, L 4 or 6 hours. Professor HAZEN.

Botany 151-152—Bacteria and Ferment Fungi. C 2 hours, L 6 hours. 3 or 5 points.

Botany 153—Anatomy of Vascular Plants. C 2 hours, L 6 hours. 3 or 5 points. Mrs. RICHARDS (Barnard).

Botany 154—Physiology of Plants from Standpoint of Nutrition. C 2 hours, L 6 hours. 5 points (C only 3 points). Professor RICHARDS and Mrs. RICHARDS (Barnard).

Botany 156—Physiology of Plants from Standpoint of Growth. C 2 hours, L 6 hours. 5 points (C only 3 points). Not given 1917-1918. Professor RICHARDS and Mrs. RICHARDS (Barnard).

Botany 158—Structure and Development of Algæ. Advanced course. C 1 hour, L 6 hours. 4 points. Professor HAZEN.

Botany 159—Structure and Development of Fungi. Advanced course. C 1 hour, L 6 hours. 4 points. Professor RICHARDS.

Botany 160—Embryology and Laboratory Methods. Practice in methods of technique, with the study of the embryology of one or more types. L 8 hours with occasional lectures and outside reading. 4 points. Professor HAZEN.

Botany 161-162—Advanced Physiology and Morphology. Work will be arranged to suit the needs of the students. 4 or 8 points. Professors RICHARDS and HAZEN and Mrs. RICHARDS (Barnard).

Summer Session and Extension Teaching
(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education,

are given in the Department of Biology of Teachers College by Professors BIGELOW and BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in the current *Announcement of Teachers College*.

Courses in the College of Pharmacy

A course of 30 lectures, 30 recitation hours and 75 hours laboratory work in structural and descriptive botany; a laboratory course of 90 hours in botany applied to the study of drugs; and a course of 30 hours in plant classification are given in the College of Pharmacy.

Courses in Biometrical Methods

(See page 25)

PATHOLOGY

Pathology 101-102—General and Special Pathology. C 1 hour, L 2 hours. 2 points each session. Professors MACCALLUM and PAPPENHEIMER and Drs. LAMBERT, MACKENZIE and others.

Pathology 105-106—Gross Pathological Anatomy and Attendance upon Autopsies. 1 point each session. Professors MACCALLUM and PAPPENHEIMER and Drs. LAMBERT, MACKENZIE and others.

Pathology 107—Experimental Pathology. 3 hours. 2 points. Limited to twelve students. Professor MACCALLUM.

Pathology 201-202—Advanced Pathology. The officers of the department.

Credit for this course varies from 2-8 points each session, according to arrangements made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Pathology 251-252—Research in Pathology. 6-10 points each session. Under the direction of the professor of pathology. The officers of the department.

Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

See also additional courses listed under George Crocker Special Research Fund on page 25.

PHARMACOLOGY

Pharmacology 213-214—General Pharmacology. Lectures, 1 hour; laboratory work, 6 hours. 4 points each session. Professor LIEB.

Pharmacology 215—Biological Standardization of Drugs. Laboratory work, 7 hours; first half-year. 3 points. Professor LIEB.

The Department of Pharmacology occupies the eastern section of the third floor of North building of the College of Physicians and Surgeons. It comprises a laboratory for undergraduate instruction in pharmacology and pharmacy, three research laboratories, a chemical laboratory and a well-equipped shop. The laboratories are supplied with all apparatus necessary for the investigation of pharmacological problems.

PHYSIOLOGY

Students who are candidates for one of the graduate degrees with physiology as their primary choice should have some knowledge of physics, chemistry and

biology. The specific requirements for the degree depend, in part, upon the previous preparation of the candidate, and he should always confer with the executive officer of the department before entering upon his work. A candidate for the degree of Master of Arts who has had no previous work in physiology is expected to take either Physiology 106-107 or Physiology 201-202 and 203-204, together with such other work as the department may prescribe.

Physiology 2—Elementary Physiology. C 2 hours, L 4 hours. 516 S. 3 points. Dr. SCOTT (E. L.).

Physiology 106-107—Human Physiology. Lectures 3 hours; demonstrations 1 hour; recitations 2 hours; laboratory work 3 hours. 8 points each session. Professors BURTON-OPITZ and WILLIAMS (H. B.) and Drs. BISHOP, COX, CUTLER, LEBER and VAN KLEECK.

Physiology 108—Physics of X-Rays. Lectures with demonstrations; 1 hour; eight weeks. Professor WILLIAMS (H. B.). 1 point.

Physiology 201-202—General Physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each session. Professor PIKE and Dr. SCOTT (E. L.).

Physiology 203-204—Special Physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each session. Professors BURTON-OPITZ, PIKE and WILLIAMS (H. B.) and Dr. SCOTT (E. L.).

Physiology 205-206—Problems of Evolution from the Standpoint of Physiology. Lectures 1 hour. 1½ points each session. Professor PIKE.

Physiology 207—Clinical Physiology. The application of physiological methods to the problems of clinical medicine. Lectures and demonstrations 2 hours, first half-year. Professors BURTON-OPITZ, PIKE and WILLIAMS (H. B.) and Dr. WHEELWRIGHT. 3 points.

Physiology 208—Principles of electro-cardiography. Lectures with demonstrations; 1 hour; six weeks. Professor WILLIAMS (H. B.). 1 point.

Physiology 251-252—Research in Physiology. Under the direction of Professor LEE. The officers of the department. Hours to be arranged.

Credit for this course varies from 2 to 8 points each session according to the arrangement made at the time of registration by the student with the instructor.

Courses in Barnard College

A course in general Animal Physiology is given by the Department of Zoology of Barnard College, supplementing the work in general Biology and Zoology. See page 21 and the separately printed *Announcement of Barnard College*.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College: One dealing with Plant Nutrition, Botany 154, a second with Growth, Botany 156, a third with advanced problems in Physiology, Botany 161-162. Professor RICHARDS and Mrs. RICHARDS. See page 15 and the separately printed *Announcement of Barnard College*.

Summer Session

For information in regard to the courses in Physiology offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Courses in Teachers College

The Department of Physical Education of Teachers College offers Physical Education 55-56, Applied Physiology.

The courses in Applied Biology given in Teachers College are chiefly physiological. Professors BIGELOW and BROADHURST and Miss STACKPOLE. For details consult the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

A course of 30 lectures and 30 recitations in Human Physiology is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, pp. 15 and 16. They include Courses Nos. 101 and 102, General Plant Physiology (Professor MARQUETTE); 120, Plant Electro-physiology (Professor MARQUETTE); 201-208, Advanced Physiology (Professors RICHARDS, CURTIS and MARQUETTE); Physiology of Nutrition (Professors RICHARDS and GIES).

NEUROLOGY

Neurology 231-232—Clinical Psychology (Psychopathology) and Psychotherapy, inclusive of the Psychopathology, Psychotherapy, and Mental Examination of the Psychopathic Child. At the Vanderbilt Clinic; clinical lectures; one hour for one-half year. Dr. HABERMAN. This course may be elected for either the first or the second half-year.

ZOOLOGY

Graduate work in zoology requires at least two years of preparatory undergraduate study or the equivalent, *i.e.*, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology, and microscopical technique. Such a preparation is afforded by Courses 1-4, 51, 91-92, and 93 or 95-96. For students whose main interest lies in other subjects less extensive preparation may suffice, but such students must have taken at least one year's work in zoology or elementary biology. Courses numbered below 100 are for undergraduates only.

The degree of Master of Arts in Zoology requires courses approved by the department, or their equivalent, aggregating a minimum of 30 tuition points, 16 of which at least shall be in courses in Zoology, and such other work towards the attainment of a sufficient standard of scholarship as the department may require.

For the degree of Doctor of Philosophy the course requirement is less rigid, emphasis being laid upon the attainment of a sufficient standard of knowledge and training as shown particularly by the dissertation. Candidates are, however, expected to take such course work as the department may recommend, including work in other departments, the total amount being normally about twice that required for the degree of Master of Arts. For either degree specially assigned study or research (to be registered as Course 227-228) may in part, with the approval of the department, take the place of formal course-work. To Ph.D. students whose main work is in Zoology, Courses 201, 215-216, 221-222, 223-224, and 225-226 are suggested as a general foundation.

All the graduate courses are open to women.

A. Undergraduate Courses

Zoology 1-2—Elementary Biology (Zoology). C 2 hours, L 4 hours. Professors CALKINS and MCGREGOR, Dr. PACKARD (Columbia College); Professors CRAMPTON and L. H. GREGORY, Dr. DEDERER (Barnard College).

Zoology 3—Elementary Histology. 1 hour. Dr. DEDERER (Barnard College).

Zoology 4—Elementary Embryology. C 1 hour, L 2 hours. Professor MORGAN (Columbia College); Professor CRAMPTON (Barnard College).

Zoology 5—General Biology. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

Prerequisite: *Zoology 1-2.*

Zoology 6—Experimental Biology. An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. C 1 hour, L 2 hours. Professor CRAMPTON (Barnard College).

Zoology 7-8—Biology and Genetic Relations of the Human Organism. General anatomy and physiology of the human type in comparison with other organisms; the biological basis of individual hygiene, of human genetics, and social relations. W. and F. at 3. 4 points. Professors CRAMPTON and L. H. GREGORY (Barnard College).

Open to students of all classes. Students who have previously taken *Zoology 1-2* will receive only 2 points credit. This course does not count as fulfilling the prescribed requirement in science for the A.B. or B.S. degree.

Zoology 9—Theories of Modern Biology. Open to qualified students of Columbia College. Lectures and discussions. Tuesday and Thursday at 2. 2 points. Professor CALKINS.

Prerequisite: *Zoology 1*, except by special permission of the instructor. (Given in spring term of 1917-1918.)

Zoology 51—Histology and Technique. The preparation and study of animal tissues. C 1 hour, L 4 hours. Dr. PACKARD.

Zoology 53-54—Practical Zoology and Embryology. 2 points. Dr. DEDERER (Barnard College).

Zoology 91-92—General Zoology. C 2 hours, L 6 hours. Professor MCGREGOR (Columbia College).

Zoology 92—Comparative Embryology of Vertebrates. C 1 hour, L 2 hours. Professor MCGREGOR (Columbia College).

Zoology 95-96—Comparative Morphology of Vertebrates. C 1 hour, L 4 hours. Professor MCGREGOR.

Prerequisite: *Zoology 1-2*.

B. Graduate Courses

Zoology 101-102—General Zoology. C 2 hours, L 6 hours. 5 points each session. Professor MCGREGOR (Columbia College); Professors CRAMPTON and L. H. GREGORY, Dr. DEDERER (Barnard College).

This course covers the same general ground as *Zoology 91-92*, but is supplemented by additional assigned work.

Zoology 103—Comparative Embryology of Vertebrates. C 1 hour, L 2-5 hours. 3 points. Professor MCGREGOR.

Covers the same ground as *Zoology 93*, with additional assigned work.

Zoology 110—The Parasitic Protozoa. C 1 hour, L 4 hours. 3 points. Professor CALKINS.

A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had *Zoology 91* or its equivalent.

Zoology 151-152—General Physiology. General principles of human and animal physiology. C 2 hours, L 4 hours. 4 points each session. Professor L. H. GREGORY (Barnard College). Open to women only.

C. Advanced Graduate Courses

General Zoology

The two following courses are designed to complete the work in general zoology begun in *Zoology 1-2* and continued in *Zoology 91-92*. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

Zoology 201—Topics in Invertebrate Zoology, with Especial Reference to Problems of Phylogeny. C 2 hours, L 8-10 hours. 8 points. Professor WILSON.

Zoology 223-224—Evolution of the Vertebrates. I (223), Fishes Recent and Fossil. II (224), Amphibia and Reptiles; Origin of the Birds; Origin of the Mammals. Systematic, phylogenetic, and morphological studies. Evolution of the head and locomotive apparatus of vertebrates. C 2 hours, L 3 hours. 4 points each session. Given at the American Museum. Professor W. K. GREGORY.

The material studied comprises over 700 specimens of recent and fossil types.

Zoology 225-226—Cellular Biology. General structure and functions of the cell with especial reference to development and heredity, cytology and cellular embryology. C 2 hours, L 6 hours. 6 points each session. Professor WILSON.

Morphology and Evolution of Special Groups

Zoology 203-204—Mammals, Living and Fossil. C 1 hour, L 5-10 hours. 4 points each session. Professor W. K. GREGORY.

Structure, origin, and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum.

Protozoology

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life histories, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Parasitic Protozoa (see page 23).

Zoology 221-222—Protozoology. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology, and physiology. C 1 hour, L 8 hours. 5 points each session. Professor CALKINS.

Zoology 230—Experimental Protozoology. C 1 hour, L 4 hours. 4 points. Professor CALKINS.

The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization, and age. Individual research problems for registered students.

Prerequisite: 221.

Experimental Zoology

The following courses (215-218 with 213-214) cover three years' work. Each course may be taken independently of the others and not necessarily in the order given.

Zoology 213—Tropisms. (To be given 1918.) C 1 hour, L 5 hours. 4 points. Professor MORGAN.

This course deals with the simpler responses of organisms to external agents and serves as an introduction to the next course, *Zoology 214*.

Prerequisite: *Zoology 1-2, 91-92*.

Zoology 214—Instincts. (To be given 1919.) An analysis of the more complex behavior of animals and the problems of the evolution of instinct and intelligence. C 1 hour, L 5 hours. 4 points. Professor MORGAN.

Prerequisite: *Zoology 1-2, 91-92*.

Zoology 215-216—Genetics. C 2 hours, L 6 hours. 6 points each session. Laboratory work on special problems. Professor MORGAN.

Approximately half of the year is given to Mendelian heredity and genetics; the remainder to the influence of the environment in modifying organisms and in affecting their modes of reproduction (sex determination).

Zoology 217—Physiological Morphology. (To be given 1917.) C 1 hour, L 5 hours. 4 points. Professor MORGAN.

A discussion of theories dealing with the relation of function and structure as illustrated by growth, regeneration, transplantation, and tissue culture.

Zoology 218—Experimental Embryology. (To be given 1918.) The rôle of external factors in development. C 1 hour, L 5 hours. 4 points. Professor MORGAN.

Special Research

Zoology 227-228—Investigation of special problems in any of the subjects enumerated above. Variable. Not in general counted as part of course-work.

Courses in Biometrical Methods

Anthropology 121—Anthropometry—Biometrical Methods. C 2 hours. 3 points. Professor BOAS.

This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the inter-relations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged.

Anthropology 122—Anthropometry—Growth. C 2 hours. 3 points. Professor BOAS.

A discussion of the phenomena of growth with special relation to the influences of heredity and of environment.

Courses under the George Crocker Special Research Fund

Zoology 209—Morphology and Classification of Tumors, including Pathological Technique. 4 points. Professor WOOD.

Prerequisite: Mammalian histology.

Zoology 202—General Biology of Tumors. 4 points. Professor WOGLOM.

Prerequisite: Mammalian histology.

Zoology 205-206—Research in Problems of Growth Pathology with Especial Reference to Tumors. Credit to be assigned in individual cases at the time of registration. 4-12 points each session. Professors WOOD and WOGLOM and Drs. PRIME and BULLOCK.

The laboratories of the George Crocker Special Research Fund are open to properly qualified workers for research in pathology under the supervision of the Director of Cancer Research.

Course in the College of Pharmacy

A laboratory course of 200 hours in the general biology of plants and animals is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

Courses in the College of Physicians and Surgeons

Zoology 101—Histology and Embryology. 12 hours. 8 points. Professors SCHULTE and MILLER and Drs. STRONG and SHARP.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors BIGELOW and BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in the current *Announcement of Teachers College, School of Education*.

ACADEMIC CALENDAR

1917-1918

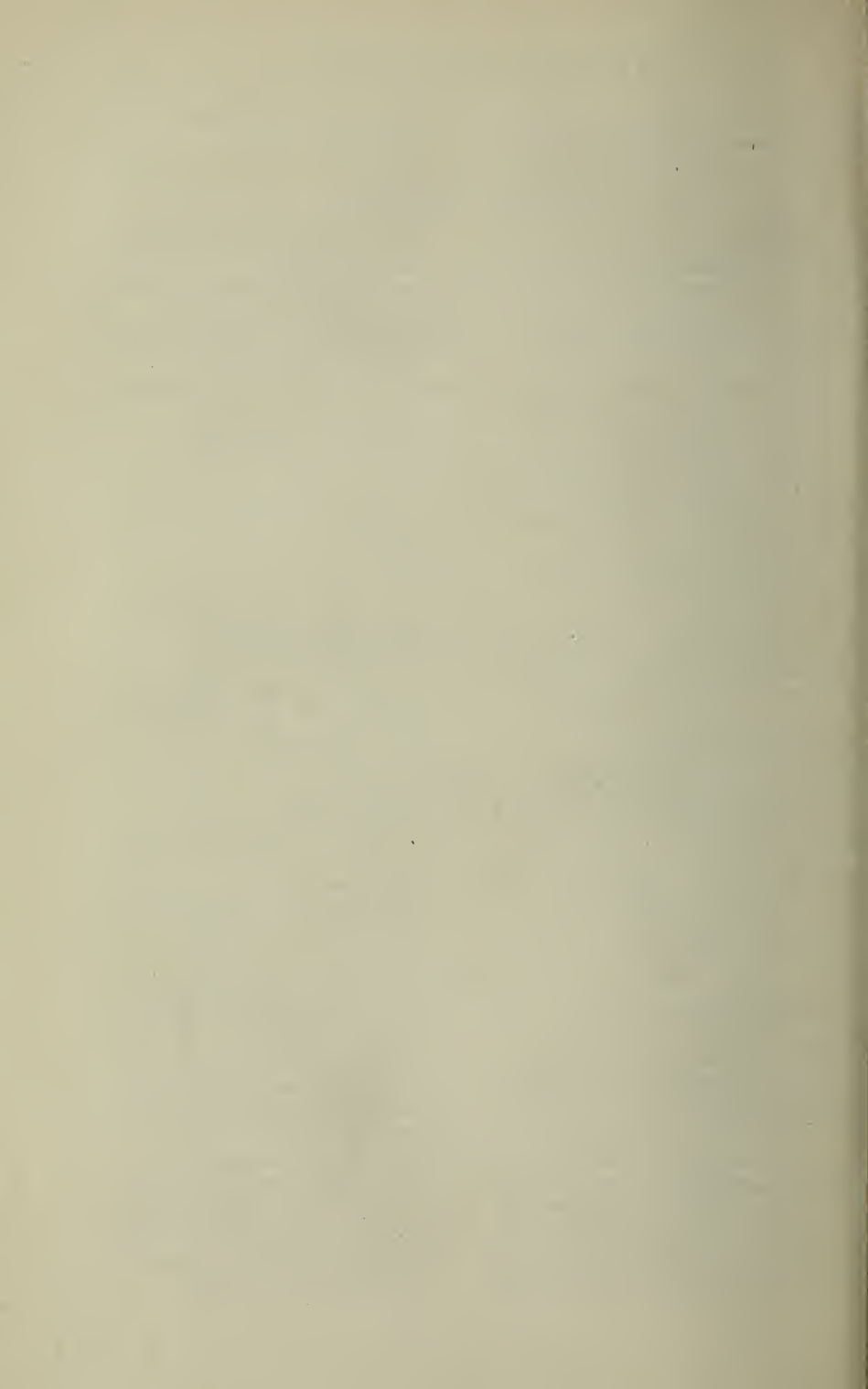
1917

- July 9, Monday. Eighteenth **Summer Session begins.**
- Aug. 17, Friday. Eighteenth **Summer Session ends.**
- Sept. 10, Monday. Last day for filing applications for entrance examinations, and for advanced standing. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 17, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.
- Sept. 19, Wednesday. **Registration** (including the payment of fees) **begins.**
- Sept. 25, Tuesday. Registration ceases for students previously matriculated, except in the graduate schools. The privilege of later registration may be granted on payment of a fee of \$5.
- Sept. 26, Wednesday. **Winter Session, 164th year, begins.** Registration ceases for students not previously matriculated, except in the graduate schools. The privilege of later registration may be granted on payment of a fee of \$5.
- Sept. 28, Friday. French and German reading tests.
- Sept. 29, Saturday. Registration ceases in the graduate schools. The privilege of later application may be granted up to October 20 on payment of a fee of \$5. Last day for making changes in program, except in the graduate schools.
- Oct. 1, Monday. Last day for filing applications for all degrees to be conferred in October, except Master of Arts, Master of Science, Master of Laws and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Oct. 16, Tuesday. Stated meeting of University Council.
- Oct. 20, Saturday. Last day for receiving late applications for registration and for making changes in program in the graduate schools.
- Nov. 6, Tuesday. Election Day, holiday.
- Nov. 28, Wednesday. **Annual Thanksgiving Service** in St. Paul's Chapel.
- Nov. 29, Thursday, to December 1, Saturday, inclusive, Thanksgiving holidays.
- Dec. 9, Sunday. **Annual Commemoration Service** in St. Paul's Chapel.
- Dec. 18, Tuesday. Stated meeting of University Council.
- Dec. 22, Saturday, to

1918

- Jan. 7, Monday, inclusive. Christmas holidays.
- Jan. 10, Thursday. Last day for filing applications for entrance examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Jan. 17, Thursday. Mid-year entrance examinations begin.
- Jan. 23, Wednesday. Mid-year examinations begin.

- Feb. 1, Friday. Last day for filing applications for all degrees to be conferred in February, except Master of Arts, Master of Science, Master of Laws and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Feb. 4, Monday. Registration (including the payment of fees) begins.
- Feb. 5, Tuesday. **Winter Session ends.** Last day for filing essay for the degrees of Master of Arts, Master of Science and Master of Laws to be conferred in February.
- Feb. 6, Wednesday. **Spring Session begins.**
University Service in St. Paul's Chapel.
 Registration ceases for students entering Spring Session. The privilege of later registration may be granted up to March 2 in the graduate schools on payment of the fee of \$5.
- Feb. 9, Saturday. Last day for making changes in program, except in the graduate schools.
- Feb. 12, Tuesday. Alumni Day.
- Feb. 19, Tuesday. Stated meeting of University Council.
- Feb. 22, Friday. Washington's Birthday, holiday.
- Mar. 1, Friday. Last day for filing applications for University Fellowships and Scholarships.
- Mar. 28, Thursday, to April 1, Monday, inclusive. Easter holidays.
- Apr. 15, Monday. Last day for filing applications for all degrees to be conferred in June, except Master of Arts, Master of Science, Master of Laws and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Apr. 16, Tuesday. Stated meeting of University Council.
- Apr. 22, Monday. Last day for filing applications for deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.
- May 20, Monday. Final Examinations begin.
- May 30, Thursday. Memorial Day, holiday.
- June 2, Sunday. **Baccalaureate Service.**
- June 3, Monday. Class Day.
- June 5, Wednesday. **Commencement Day.**
- June 12, Wednesday. **Spring Session ends.**
- June 17, Monday. Entrance examinations begin.
- July 8, Monday. Nineteenth **Summer Session begins.**
- Aug. 1, Last day for filing applications for deficiency examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Aug. 16, Friday. Nineteenth **Summer Session ends.**
- Sept. 9, Monday. Last day for filing applications for entrance examinations, and for advanced standing. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 16, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.
- Sept. 18, Wednesday. **Registration** (including the payment of fees) **begins.**
- Sept. 24, Tuesday. Registration ceases for students previously matriculated, except in the graduate schools. The privilege of later application may be granted on payment of a fee of \$5.



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Eighteenth Series, No. 35

July 20, 1918



Columbia University Bulletin of Information

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DIVISION OF BIOLOGY

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COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT ✓

1918-1919

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Columbia University Bulletin of Information

[Issued thirty-five times during the academic year, monthly in November, and weekly between December and July. Entered as second-class matter at the New York, N. Y., Post Office, December 22, 1900, under the Act of July 16, 1894.] These issues include:

1. Annual Reports of the President and Treasurer to the Trustees.
2. The Catalogue of the University, price twenty-five cents, and the Announcements of the several Colleges and Schools, and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University.

U.P.O.-2,000-1918.

Although the specific courses announced in this Bulletin may be changed because of war conditions, the educational opportunities will remain substantially as herein stated.

OFFICERS OF THE DIVISION OF BIOLOGY

- GEORGE S. HUNTINGTON *Professor of Anatomy, Executive officer,
Department of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D., Jefferson
Medical College, 1907.
- HENRY FAIRFIELD OSBORN *Research Professor of Zoology*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901; Princeton, 1902;
Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.) Christiania, 1911; Member of
National Academy of Sciences.
- EDMUND B. WILSON *Da Costa Professor of Zoology, Executive officer,
Department of Zoology*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902; LL.D.,
Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.) Leipsic, 1909; Member of National
Academy of Sciences.
- FREDERIC S. LEE *Dallan Professor of Physiology, Executive officer,
Department of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN *Professor of Vertebrate Zoology*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D., 1890; Chevalier
de la Légion d'Honneur, 1910.
- HENRY E. CRAMPTON *Professor of Zoology*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES *Professor of Biological Chemistry, Executive officer,
Department of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Sc.D., 1914; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS . . . *Professor of Botany and Secretary of the Division*
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS *Professor of Protozoology*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.
- MAURICE A. BIGELOW *Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- RUSSELL BURTON-OPITZ *Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN *Professor of Experimental Zoology*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; LL.D., 1915; Member
of National Academy of Sciences.
- BERN B. GALLAUDET *Assistant Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.
- JOHN HENRY LARKIN *Assistant Professor of Pathology*
A.B., Manhattan, 1891; M.D., Columbia, 1894.
- JAMES HOWARD MCGREGOR *Associate Professor of Zoology*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- CARLTON CLARENCE CURTIS *Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.

- TRACY E. HAZEN *Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- ROBERT A. HARPER *Torrey Professor of Botany, Executive officer,*
Department of Botany
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences.
- WILLIAM G. MARQUETTE *Associate Professor of Botany*
Ph.G., Northwestern, 1899; B.S., Wisconsin, 1903; Ph.D., 1907.
- FRANK HENRY PIKE *Associate Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- CHARLES C. LIEB *Assistant Professor of Pharmacology, Executive officer,*
Department of Pharmacology
A.B., Columbia, 1902; M.D., 1906.
- HANS ZINSSER *Professor of Bacteriology, Executive officer,*
Department of Bacteriology
A.B., Columbia, 1899; A.M. and M.D., 1903.
- ALWIN M. PAPPENHEIMER *Assistant Professor of Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY *Professor of Neurology*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- JEAN BROADHURST *Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908; Ph.D., Cornell, 1914.
- HORATIO B. WILLIAMS *Assistant Professor of Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- WILLIAM K. GREGORY *Assistant Professor of Vertebrate Palæontology*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- LOUISE HOYT GREGORY *Assistant Professor of Zoology in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- VERA DANTSCHAKOFF *Assistant Professor of Anatomy*
M.D., Lausanne, 1902; M.D., Charkow, 1903; Petrograd Academy of Medicine, 1907.
- JAMES W. JOBLING *Professor of Pathology*
M.D., Tennessee Medical College, 1897.
- CHARLES H. BAILEY *Associate in Pathology*
A.B., Brown, 1903; M.D., Harvard, 1910.
- RICHARD H. CUNNINGHAM *Associate in Physiology*
M.D., Medical College of Virginia, 1886; M.D., Columbia, 1888.
- JAMES G. DWYER *Associate in Bacteriology*
A.M., Queen's, 1902, M.D., 1905; Ph.D., Columbia, 1918.
- ADOLPH ELWYN *Associate in Anatomy*
B.S., Columbia, 1915; A.M., 1917.
- ERNEST L. SCOTT *Associate in Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911; Ph.D., Columbia, 1914.
- JOHN C. VAUGHAN *Associate in Anatomy*
M.D., Columbia, 1907.
- JOSEPH S. WHEELWRIGHT *Associate in Physiology*
A.B., Yale, 1897; M.D., Cornell, 1900.

- FRANK WARNER BISHOP *Instructor in Physiology*
B.S., Columbia, 1910; M.D., 1912.
- WILLIAM F. BENDER *Instructor in Physiology*
M.D., Columbia, 1913.
- GASTON A. CARLUCCI *Instructor in Anatomy*
M.D., Columbia, 1908
- BERNARD O. DODGE *Instructor in Botany*
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- ANDREW A. EGGSTEIN *Instructor in Pathology*
B.S., Vanderbilt, 1908; M.D., 1912.
- F. WALTER GRAVELLE *Instructor in Anatomy*
M.D., Queen's, 1911.
- HATTIE L. HEFT *Instructor in Physiological Chemistry*
Teachers College
B.S., Louisville, 1912; M.S., 1913; A.M., Columbia, 1914; Ph.D., 1917.
- FLORENCE HULTON-FRANKEL *Instructor in Bacteriology*
B.S., Pennsylvania, 1907; M.S., 1914; Ph.D., 1916.
- JOHN D. KERNAN, JR. *Instructor in Anatomy*
A.B., Harvard, 1900; M.D., Columbia, 1903.
- OTTO H. LEBER *Instructor in Physiology*
A.B., Columbia, 1904; M.D., 1908.
- KARL J. LOEWI *Instructor in Anatomy*
M.D., Vienna, 1904.
- FLORENCE DEL. LOWTHER *Instructor in Zoology in Barnard College*
A.B., Columbia, 1912; A.M., 1915.
- HYMEN R. MILLER *Instructor in Bacteriology*
B.S., Columbia, 1908; M.D., 1911.
- HERMANN J. MULLER *Instructor in Zoology*
A.B., Columbia, 1910; A.M., 1911.
- REUBEN OTTENBERG, M.D. *Instructor in Bacteriology*
A.B., Columbia, 1902; M.D., 1905.
- HESTER M. RUSK *Instructor in Botany in Barnard College*
A.B., Columbia, 1912; A.M., 1917.
- EMILY C. SEAMAN *Instructor in Physiological Chemistry, Teachers College*
B.S., Adelphi, 1899; A.M., Columbia, 1905; Ph.D., 1912.
- CAROLINE STACKPOLE *Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- JOHN A. VIETOR *Instructor in Anatomy*
A.B., Yale, 1907; M.D., Columbia, 1911.
- EDNA HENRY BENNETT *Lecturer in Zoology in Barnard College*
A.B., Columbia, 1915.
- MARION E. RICHARDS *Lecturer in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- CORNELIA L. CAREY *Assistant in Botany in Barnard College*
- HELEN C. COOMBS *Research Assistant in Physiology*
A.B., Columbia, 1911; B.S., 1914; A.M., 1915; Ph.D., 1918.

- SAMUEL C. DELLINGER *Assistant in Zoology*
A.B., Trinity (N. C.), 1915.
- JAMES B. HALLAM *Assistant in Anatomy*
D.O., Philadelphia College and Infirmary of Osteopathy, 1905; M.D., New York Homeopathic Medical College, 1914.
- ALFRED F. HUETTNER *Assistant in Zoology*
A.B., South Dakota, 1916.
- FRANCES KRASNOW *Assistant in Bacteriology*
- FRANZ SCHRADER *Assistant in Zoology*
B.S., Columbia, 1914.

MEMBERS OF THE STAFF OF THE BOTANICAL GARDEN GIVING
INSTRUCTION IN THE DIVISION

- NATHANIEL LORD BRITTON, Ph.D., Sc.D. *Director*
- WILLIAM ALPHONSO MURRILL, Ph.D. *Assistant Director*
- ARLOW BURDETTE STOUT, Ph.D. *Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D. *Head Curator of the Museums*
- FRED. JAY SEAVER, Ph.D. *Curator*
- PER AXEL RYBERG, Ph.D. *Curator*
- ARTHUR HOLLICK, Ph.D. *Curator*
- MARSHALL AVERY HOWE, Ph.D. *Curator*
- GEORGE VALENTINE NASH *Curator of the Plantations*
- HENRY HURD RUSBY, M.D. *Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D. *Consulting Chemist*

Partial courses are also given by

- ELIZABETH GERTRUDE BRITTON EDWARD SANFORD BURGESS, Ph.D.

UNIVERSITY OFFICERS OF ADMINISTRATION

- WILLIAM H. CARPENTER, Ph.D. *Provost of the University*
- FRANK DIEHL FACKENTHAL, A.B. *Secretary of the University*
- FRANK A. DICKEY, A.B. *Registrar of the University*
- CHARLES S. DANIELSON *Bursar of the University*
- HENRY L. NORRIS, M.E. *Superintendent of Buildings and Grounds*
- REV. RAYMOND C. KNOX, S.T.D. *Chaplain of the University*
- GEORGE L. MEYLAN, M.D. *Medical Director of the Gymnasium*
- WILLIAM H. MCCASTLINE, M.D. *University Medical Officer*

GENERAL STATEMENT

The Division of Biology includes the following departments, Anatomy, Bacteriology, Biological Chemistry, Botany, Pathology, Pharmacology, Physiology, and Zoology, which offer courses of study leading to university degrees. This bulletin is designed primarily for advanced students and for candidates for the degrees of Master of Arts and Doctor of Philosophy. Other students should consult the announcements of Columbia College, Barnard College, Extension Teaching, College of Physicians and Surgeons, Teachers College, School of Education and Practical Arts, which may be had from the Secretary of the University.

The university requirements for the degrees of Master of Arts and Doctor of Philosophy are stated in full in the Announcement of the Faculties of Political Science, Philosophy and Pure Science, which will be sent upon application to the Secretary of the University. This Announcement contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments, university and tuition fees, and all other university matters of interest to advanced students. Special departmental requirements for the degrees of Master of Arts and Doctor of Philosophy are stated under the separate departmental headings.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those for men.

Funds and Prizes. Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy. The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology. The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media. The labora-

tories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

Biological Chemistry (Nutrition). At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor GIES' library occupies a room adjoining the laboratory and is accessible by appointment and to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoological Park for research, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany. The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultraviolet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammeters, resistance-measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus, affords facilities for experimental work in physiology and pathology, and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University, the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment, and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic

collections are in special rooms. Ample opportunity for experimental work in plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses.

The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

A seminar for the study of special subjects in general physiology meets weekly, and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a bi-weekly colloquium.

Pathology. The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, amphitheater, photographic rooms, etc., on the fifth floor. On the fourth floor, there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a clinical laboratory, the museum, preparation rooms, cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology. The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises two laboratories, which are provided with special apparatus for teaching purposes; six laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, mainly for research; a library containing sets of the physiological journals, monographs and other books, and many reprints of special articles; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoology. The zoological laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoology, and eight rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes, and other apparatus for advanced work.

Owing to the accessibility of the collections of the American Museum of Natural History (see below), the department does not maintain a general zoological

museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, charts and wax models, and an aquarium room.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works, and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoology and palæontology of invertebrates and vertebrates, both from the systematic and bionomic points of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoological Park in the Borough of the Bronx, under the direction of the New York Zoological Society, affords exceptional opportunities for the study of living reptiles, birds, and mammals.

The New York Aquarium, also under the management of the Zoological Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets every week in the department library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

The Marine Biological Laboratories at Woods Hole, Massachusetts, and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, five investigators' rooms (ten tables) are subscribed for by the University for the use of the Department of Zoology; in the latter, a table is available through the John D. Jones Scholarship. The University also maintains an investigators' table at the Naples Zoological Station.

Publications by Members of the Division. The Columbia University Press issues the *Columbia University Biological Series*, of which ten volumes have already appeared.

The Department of Physiology issues *Studies from the Department of Physiology*, of which six volumes have already appeared.

ANATOMY

Anatomy 101—Histology and Embryology. Lectures, conferences, and laboratory work 12 hours. 8 points. Mr. ELWYN.

Anatomy 103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences, and dissections 12 hours. 8 points each session. Department staff.

Anatomy 105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work, and dissection 12 hours. 6 points. Professor GALLAUDET and Dr. VAUGHAN.

Anatomy 107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations 3 hours. 3 points. Professor HUNTINGTON.

Anatomy 202—Special Morphology. 3 hours. 3 points. Professor HUNTINGTON.

Anatomy 251-252—Research in Anatomy. Under the direction of the professor of anatomy. The officers of the department. Credit for this course varies from 2 to 8 points each session, according to the arrangement made at the time of registration by the student with the instructor.

BACTERIOLOGY

Preliminary Statement

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. They should fulfil the requirements exacted of candidates for entrance to the medical school. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoology in the Department of Zoology.

For the degree of Master of Arts the student must include among the courses he elects Courses 201, 205, 206, and 208. An essay based on work of a research nature or a critical review is also required.

For admission to candidacy for the Ph.D. degree, the student must be able to read French and German, must have done the work in Courses 201, 205, 206, and 208 and must be recommended by the department as able to undertake research.

Courses 201 and 203, 205-206, 208, 211-212, 251-252 are open to women.

Bacteriology 101—General Bacteriology, especially adapted to the requirements of students of medicine. Six hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty; 5-6 points. Professor ZINSSER and Dr. DWYER.

Bacteriology 201—Advanced Bacteriology. The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon, in October, November, December, and January. 9 points. Dr. DWYER.

This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants, and of germicides.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*, Macé's *Bacteriologie*.

Bacteriology 203-204—Special Bacteriology. Rating individually determined for each case at the time of registration. 6 to 18 hours laboratory. 3-9 points.

As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; and the pursuit of some selected theme for original investigation.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*.

Attendance and hours individually arranged.

Bacteriology 205—The Principles of Infection, Immunity, Serum Diagnosis, and Therapy. Lectures with demonstrations, 1 hour. 1½ points.

Text-book: Zinsser, *Infection and Resistance*.

Bacteriology 208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twenty students. 6 points.

Prerequisites: 201 and 205.

Bacteriology 209-210—Clinical Bacteriology. Dr. DWYER. Rating individually determined at time of registration.

A course will be given at the laboratory of the Manhattan Eye, Ear and Throat Hospital in which a small group of students will be taught the methods of examining material from patients suffering from infections chiefly of the eye, ear, nose and throat, and course will include the bacteriological diagnosis of material, the making of blood cultures, the making of autogenous vaccines and their use in the treatment of patients, etc.

Bacteriology 211 or 212—Clinical Serology. 3 points. Dr. OTTENBERG and Assistants.

Technique of Wassermann reaction and other clinical serum reactions. Laboratory open to properly qualified graduate students, to physicians and to undergraduates who have taken courses 205-206 and 208 or equivalent.

Bacteriology 251-252—Research in Bacteriology. 2 to 8 points each session. Under the direction of the professor of bacteriology.

Rating individually determined at the time of registration.

Summer Session

Bacteriology s101—General Bacteriology. 5 to 6 points, equivalent to Course 101. Dr. DWYER.

Course in Barnard College

Botany 151-152—Bacteria and Ferment Fungi. C, 2 hours; L, 6 hours. 5 points. Professor RICHARDS and Miss RUSK.

Course in Teachers College

For details of a course in bacteriology applied to household arts given in Teachers College by Professor BROADHURST, see the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

For details of a laboratory course of thirty-two hours in Bacteriology, given in the College of Pharmacy, see the separately printed *Announcement of the College of Pharmacy*.

BIOLOGICAL CHEMISTRY**(Nutrition)***Courses in Nutrition (Physiological and Pathological Chemistry)*

Biological Chemistry 101 or 102—General Physiological Chemistry. C, 1 hour; L, 7 hours. 5 points. Professor GIES and Assistants

[The equivalent of this course is given at Teachers College in the School of Practical Arts (H A 127), by Professor GIES, Dr. HEFT, and Misses EHRHART and ECTMANN.]

A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes.

Required, in the second half of the first year, of candidates for M.D. Open as an elective to qualified Juniors and Seniors of Columbia College.

Biological Chemistry 202—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Practical Arts.) C, 1 hour; L, 6 hours. 4 points. Professor GIES and Dr. HEFT.

Biological Chemistry 211-212—Biochemical Methods of Research, including Clinical Methods. C, 1 hour; L, 7 hours. 5 points each session.

Biological Chemistry 221-222—Nutrition in Health (advanced physiological chemistry). C, 2 hours; L, 14 hours. 8 points each session. Professor GIES.

Biological Chemistry 251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 20 hours. 8 points each session. Professor GIES.

Toxicological Chemistry

Biological Chemistry 261-262—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L, 10 hours. 5 points each session. Professor GIES.

Botanical Chemistry

Biological Chemistry 271-272—Clinical Physiology of Plants. C, 1 hour; L, 7 hours. 5 points each session. (The course may be taken in whole or in part

at the New York Botanical Garden, where Professor GIES is consulting chemist.) See Botany, below. Professor GIES and Assistants.

Bacteriological Chemistry

Biological Chemistry 281-282—Chemistry of Micro-organisms; Fermentations, Putrefactions, Enzyme Actions in General (introduction to sanitary chemistry). C, 1 hour; L, 7 hours. 5 points each session. Professor GIES and Assistants.

Seminar

301-302. The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department, meet weekly to discuss results of recent researches in chemical biology. 1 hour. No course credit. Professor GIES.

Summer Session

For details of the work in Biological Chemistry offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University. It also issues the quarterly *Biochemical Bulletin* now in its sixth volume.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4, and 101-102 for men or Courses 51-52, 53-54, 153 and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

All graduate courses are open to women.

For the degree of Master of Arts the Department of Botany requires that the candidate shall complete, first, a specified number of formal courses with examinations and, second, the investigation of an assigned problem with a written report on the work done.

Matriculated candidates for the degree of Doctor of Philosophy are required by the department to have as a preliminary a reading knowledge of French and German.

In addition to the thesis embodying the results of research and the courses required for the major subject, the candidate is required to complete research work or a specified number of courses in two minor subjects, one of which must be chosen outside the department. The departmental recommendation for the degree is based on the major and minor work, the completion of the thesis and the final examination.

The proportionate amount of time to be devoted to course-work and research and the choice of the courses and the problem will be determined on consultation with the member of the staff with whom the research work is to be done.

A. Undergraduate Courses

Botany 1-2—General Botany. C, 2 hours; L, 4 hours. Professor CURTIS and Mr. NIXON.

Botany 3-4—Plant Morphology. C, 2 hours; L, 4 hours. Professor CURTIS and Dr. DODGE.

Botany 5—Elementary Plant Pathology. C, 1 hour; L, 3 hours. Dr. DODGE.

Botany 6—Economic Botany. C, 1 hour; L, 3 hours. Dr. DODGE.

Botany 7—Growth and Character of Timber. C, 1 hour; L, 3 hours. Professor CURTIS and Mr. NIXON.

Botany 9-10—Botanical Problems. Introductory to research. Professors HARPER, CURTIS, and MARQUETTE.

Botany 11-12—Plant Anatomy and Histology. C, 2 hours; L, 4 hours. Professor MARQUETTE.

B. Graduate Courses

Botany 101-102—Plant Physiology. C, 2 hours; L, 6 hours. 4 points each session. Professor MARQUETTE.

Botany 103-104—Structure and Development of Plants. A general survey of the plant kingdom from the standpoint of structure and phylogeny. 3 or 5 points each session. Professor CURTIS and Dr. DODGE.

Botany 113-114—Morphology of the Higher Plants. Study of the orders, including the structure and relationships of plants. 3 or 5 points each session. Professor CURTIS and Mr. NIXON.

Botany 115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Botany 117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Botany 120—Plant Electro-physiology. Lectures on the production of electrical disturbances in plant tissues; reactions of plants to electrical stimulation; application to crop production. 3 points. Professor MARQUETTE.

Botany 121-122—Advanced Morphology. Bryophyta and Pteridophyta. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Prerequisite: *Botany 103-104.*

C. Advanced Graduate and Research Courses

Hours and credit for courses in research (**Botany 200 to 244**) are arranged on consultation and should be recorded at the office of the Registrar.

Botany 201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to environmental factors. 4 or 8 points each session. Professors RICHARDS, CURTIS, and MARQUETTE.

Botany 209-210—Physiology of Nutrition. Treated from a chemical standpoint. 4 or 8 points each session. Professors RICHARDS and GIES.

Botany 211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. 4 or 8 points each session. Professor HARPER and Drs. MURRILL, SEAVER, and DODGE.

Botany 217-218—Embryology of Spermatophyta. With special work during two summers. 4 or 8 points each session. Professors CURTIS and HAZEN.

Botany 219-220—Morphology. Work dealing with morphological problems in the various groups of plants. 4 or 8 points each session. Directed by members of the department and Botanical Garden staff.

Botany 227-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. 4 or 8 points each session. Directed by members of the Botanical Garden staff.

Botany 235-236—Plant Distribution. Problems dealing with regional botany or plant geography. 4 or 8 points each session. Professor BRITTON and other members of the staff.

Botany 241-242—Research on the Physiology of the Cell and Reproduction. 4 or 8 points each session. Professor HARPER.

Botany 243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. 4 or 8 points each session. Dr. STOUT.

Botany 301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. 2 points each session. Professor HARPER.

Botany 303-304—Seminar for the study of problems in plant physiology. 2 points each session. Professor MARQUETTE.

Colloquium. A bi-weekly meeting for the discussion of current botanical literature.

Conference. A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Botany 51-52—Principles of Plant Morphology and Physiology. C, 2 hours; L, 4 hours. Professor RICHARDS, Miss RUSK (Barnard), and Miss CAREY.

Botany 53-54—General Morphology and Development of Plants. C, 2 hours; L, 4 hours. Professor HAZEN and Miss CAREY (Barnard).

Botany 55-56—Morphology and Classification of Spermatophytes. Study of the Natural Orders. C, 1 hour; L, 4 or 6 hours. Professor HAZEN.

Botany 58—Principles of Agriculture. C, 2 hours; L, 4 hours. Miss RUSK.

Botany 151-152—Bacteria and Ferment Fungi. C, 2 hours; L, 6 hours. 3 or 5 points. Professor RICHARDS and Miss RUSK.

Botany 153—Anatomy of Vascular Plants. C, 2 hours; L, 6 hours. 3 or 5 points. Mrs. RICHARDS (Barnard).

Botany 154—Physiology of Plants from Standpoint of Nutrition. C, 2 hours; L, 6 hours. 5 points (C only 3 points). Not given 1918-1919. Professor RICHARDS and Mrs. RICHARDS (Barnard).

Botany 158—Structure and Development of Algæ. Advanced course. C, 1 hour; L, 6 hours. 4 points. Professor HAZEN.

Botany 159—Structure and Development of Fungi. Advanced course. C, 1 hour; L, 6 hours. 4 points. Professor RICHARDS.

Botany 160—Embryology and Laboratory Methods. Practice in methods of technique, with the study of the embryology of one or more types. L, 8 hours with occasional lectures and outside reading. 4 points. Professor HAZEN.

Botany 161-162—Advanced Physiology and Morphology. Work will be arranged to suit the needs of the students. 4 or 8 points. Professors RICHARDS and HAZEN and Mrs. RICHARDS (Barnard).

Summer Session and Extension Teaching

(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors BIGELOW and BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in the current *Announcement of Teachers College*.

Courses in the College of Pharmacy

A course of thirty lectures, thirty recitation hours, and seventy-five hours laboratory work in structural and descriptive botany; a laboratory course of ninety hours in botany applied to the study of drugs; and a course of thirty hours in plant classification are given in the College of Pharmacy.

Courses in Biometrical Methods

See page 23

PATHOLOGY

Pathology 102—General and Special Pathology. C, 3 hours; L, 6 hours. 2 points each session. Officers of the department.

Pathology 106—Gross Pathological Anatomy and Attendance upon Autopsies. 1 point. Officers of the department.

Pathology 107—Experimental Pathology. 3 hours. 2 points. Limited to twelve students. Officers of the department.

Pathology 110—Case Study of Autopsy Material. At the Presbyterian Hospital; 3 hours; Spring Session, second year. Groups limited to twelve men. Hours to be arranged. The officers of the department.

Pathology 201-202—Advanced Pathology. The officers of the department.

Credit for this course varies from 2-8 points each session, according to arrangements made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Pathology 251-252—Research in Pathology. 6-10 points each session. Under the direction of the professor of pathology. The officers of the department.

Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

See also additional courses listed under George Crocker Special Research Fund on page 24.

PHARMACOLOGY

Pharmacology 213-214—General Pharmacology. Lectures, 1 hour; laboratory work, 6 hours. 4 points each session. Professor LIEB.

Pharmacology 215—Biological Standardization of Drugs. Laboratory work, 7 hours; first half-year. 3 points. Professor LIEB.

The Department of Pharmacology occupies the eastern section of the third floor of North building of the College of Physicians and Surgeons. It comprises a laboratory for undergraduate instruction in pharmacology and pharmacy, three research laboratories, a chemical laboratory, and a well-equipped shop. The laboratories are supplied with all apparatus necessary for the investigation of pharmacological problems.

PHYSIOLOGY

Students who are candidates for one of the graduate degrees with physiology as their primary choice should have some knowledge of physics, chemistry, and biology. The specific requirements for the degree depend, in part, upon the previous preparation of the candidate, and he should always confer with the executive officer of the department before entering upon his work. A candidate for the degree of Master of Arts who has had no previous work in physiology is expected to take either Physiology 106-107 or Physiology 201-202 and 203-204, together with such other work as the department may prescribe.

Physiology 2—Elementary Physiology. C, 2 hours; L, 4 hours. 3 points.

Physiology 106-107—Human Physiology. Lectures 3 hours; demonstrations 1 hour; recitations 2 hours; laboratory work 3 hours. 8 points each session. Professor BURTON-OPITZ and Drs. BENDER, BISHOP, and LEBER.

Physiology 108—Physics of X-Rays. Lectures with demonstrations; 1 hour; eight weeks. 1 point.

Physiology 201-202—General Physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each session. Professor PIKE.

Physiology 203-204—Special Physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each session. Professors BURTON-OPITZ and PIKE.

Physiology 205-206—Problems of Evolution from the Standpoint of Physiology. Lectures 1 hour. 1½ points each session. Professor PIKE.

Physiology 207—Clinical Physiology. The application of physiological methods to the problems of clinical medicine. Lectures and demonstrations 2 hours, first half-year. Professors BURTON-OPITZ and PIKE.

Physiology 208—Principles of electro-cardiography. Lectures with demonstrations; 1 hour; eight weeks. 1 point.

Physiology 251-252—Research in Physiology. Under the direction of Professor LEE. The officers of the department. Hours to be arranged.

Credit for this course varies according to the arrangement made at the time of registration by the student with the instructor.

Courses in Barnard College

A course in general Animal Physiology is given by the Department of Zoology of Barnard College, supplementing the work in general Biology and Zoology. See page 20 and the separately printed *Announcement of Barnard College*.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College: One dealing with Plant Nutrition, Botany 154, a second with Growth, Botany 156, a third with advanced problems in Physiology, Botany 161-162. Professor RICHARDS and Mrs. RICHARDS. See page 14 and the separately printed *Announcement of Barnard College*.

Summer Session

For information in regard to the courses in Physiology offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Courses in Teachers College

The Department of Physical Education of Teachers College offers Physical Education 55-56, Applied Physiology.

The courses in Applied Biology given in Teachers College are chiefly physiological. Professors BIGELOW and BROADHURST and Miss STACKPOLE. For details consult the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

A course of thirty lectures and thirty recitations in Human Physiology is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, pp. 14 and 15. They include Courses Nos. 101 and 102, General Plant Physiology (Professor MARQUETTE); 120, Plant

Electro-physiology (Professor MARQUETTE); 201-208, Advanced Physiology (Professors RICHARDS, CURTIS, and MARQUETTE); Physiology of Nutrition (Professors RICHARDS and GIES).

ZOOLOGY

Graduate work in zoology requires at least two years of preparatory undergraduate study or the equivalent, *i. e.*, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology, and microscopical technique. Such a preparation is afforded by Courses 1-4, 51, 91-92, and 93 or 95-96. For students whose main interest lies in other subjects less extensive preparation may suffice, but such students must have taken at least one year's work in zoology or elementary biology. Courses numbered below 100 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a high standard of scholarship and of training, as shown particularly by the doctor's dissertation. Candidates are, however, expected to attend such courses as the department may recommend, which may include courses in other departments. For the degree of Master of Arts in Zoology at least sixteen of the thirty tuition points prescribed by the University regulations must be taken in the Department of Zoology, together with such other work as the department may require. For the degree of Doctor of Philosophy it is in practice usually found desirable to attend additional courses aggregating at least thirty tuition points. For either degree specially assigned study or research (to be registered as Course 227-228) may in part, with the approval of the department, take the place of formal course-work. To Ph.D. students whose main work is in Zoology, Courses 201, 215-216, 221-222, 223-224, and 225-226 are suggested as a general foundation.

All the graduate courses are open to women.

A. Undergraduate Courses

Zoology 1-2—Elementary Biology (Zoology). C, 2 hours; L, 4 hours. Professors CALLINS and MCGREGOR, Dr. PACKARD (Columbia College); Professors CRAMPTON and L. H. GREGORY, Mrs. LOWTHER, Miss LYLE (Barnard College).

Zoology 3—Elementary Histology. 1 hour. Mrs. LOWTHER (Barnard College).

Zoology 4—Elementary Embryology. C, 1 hour; L, 2 hours. Professor MORGAN (Columbia College); Professor CRAMPTON (Barnard College).

Zoology 5—General Biology. C, 1 hour; L, 2 hours. Professor CRAMPTON (Barnard College).

Prerequisite: *Zoology, 1-2.*

Zoology 6—Experimental Biology. An introduction to the experimental study of growth, reactions to stimuli, development, inheritance, and related topics. C, 1 hour; L, 2 hours. Professor CRAMPTON (Barnard College).

Zoology 7-8—Biology and Genetic Relations of the Human Organism.

General anatomy and physiology of the human type in comparison with other organisms; the biological basis of individual hygiene, of human genetics, and social relations. W. and F. at 3. 4 points. Professors CRAMPTON and L. H. GREGORY (Barnard College).

Open to students of all classes. Students who have previously taken *Zoology 1-2* will receive only 2 points credit. This course does not count as fulfilling the prescribed requirement in science for the A.B. or B.S. degree.

Zoology 51—Histology and Technique. The preparation and study of animal tissues. C, 1 hour; L, 4 hours. Dr. PACKARD.

Zoology 53-54—Practical Zoology and Embryology. 2 points. Miss LYLE (Barnard College).

Zoology 91-92—General Zoology. C, 2 hours; L, 6 hours. Professor MCGREGOR (Columbia College).

Zoology 93—Comparative Embryology of Vertebrates. C, 1 hour; L, 2-5 hours. Professor MCGREGOR (Columbia College).

Zoology 95-96—Comparative Morphology of Vertebrates. C, 1 hour; L, 4 hours. Professor MCGREGOR.

Prerequisite: *Zoology 1-2*.

B. Graduate Courses

Zoology 101-102—General Zoology. C, 2 hours; L, 6 hours. 5 points each session. Professor MCGREGOR (Columbia College); Professors CRAMPTON and L. H. GREGORY, Miss LYLE (Barnard College).

This course covers the same general ground as *Zoology 91-92*, but is supplemented by additional assigned work.

Zoology 103—Comparative Embryology of Vertebrates. C, 1 hour; L, 2-5 hours. 3 points. Professor MCGREGOR.

Covers the same ground as *Zoology 93*, with additional assigned work.

Zoology 110—The Parasitic Protozoa. C, 1 hour; L, 4 hours. 3 points. Professor CALKINS.

A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had *Zoology 91* or its equivalent.

Zoology 151-152—General Physiology. General principles of human and animal physiology. C, 2 hours; L, 4 hours. 4 points each session. Professor L. H. GREGORY (Barnard College). Open to women only.

*C. Advanced Graduate Courses**General Zoology*

The two following courses are designed to complete the work in general zoology begun in *Zoology 1-2* and continued in *Zoology 91-92*. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

Zoology 201—Topics in Invertebrate Zoology, with Especial Reference to Problems of Phylogeny. C, 2 hours; L, 8–10 hours. 8 points. Professor WILSON.

Zoology 223-224—Evolution of the Vertebrates. I (223), Fishes Recent and Fossil. II (224), Amphibia and Reptiles; Origin of the Birds; Origin of the Mammals. Systematic, phylogenetic, and morphological studies. Evolution of the head and locomotive apparatus of vertebrates. C, 2 hours; L, 3 hours. 4 points. each session. Given at the American Museum. Professor W. K. GREGORY.

The material studied comprises over 700 specimens of recent and fossil types.

Zoology 225-226—Cellular Biology. General structure and functions of the cell with especial reference to development and heredity, cytology and cellular embryology. C, 2 hours; L, 6 hours. 3 or 6 points each session. Professor WILSON.

Morphology and Evolution of Special Groups

Zoology 203-204—Mammals, Living and Fossil. C, 1 hour; L, 5–10 hours. 4 points each session. Professor W. K. GREGORY.

Structure, origin, and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum.

Protozoology

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life histories, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Parasitic Protozoa (see page 23).

Zoology 221-222—Protozoology. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology, and physiology. C, 1 hour; L, 8 hours. 5 points each session. Professor CALKINS.

Zoology 230—Experimental Protozoology. C, 1 hour; L, 4 hours. 4 points. Professor CALKINS.

The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization, and age. Individual research problems for registered students.

Prerequisite: 221.

Experimental Zoology

The following courses (215–218 with 213–214) cover three years' work. Each course may be taken independently of the others and not necessarily in the order given.

Zoology 213—Tropisms. (To be given 1918.) C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

This course deals with the simpler responses of organisms to external agents and serves as an introduction to the next course, *Zoology 214*.

Prerequisite: *Zoology 1-2, 91-92*.

Zoology 214—Instincts. (To be given 1919.) An analysis of the more complex behavior of animals and the problems of the evolution of instinct and intelligence. C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

Prerequisite: *Zoology 1-2, 91-92*.

Zoology 215-216—Genetics. C, 2 hours; L, 6 hours. 6 points each session. Laboratory work on special problems. Professor MORGAN.

Approximately two-thirds of the year is given to Mendelian heredity and genetics; the remainder to the influence of environment in modifying organisms and in affecting their modes of reproduction (sex determination).

Zoology 217—Physiological Morphology. (To be given 1917.) C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

A discussion of theories dealing with the relation of function and structure as illustrated by growth, regeneration, transplantation, and tissue culture.

Zoology 218—Experimental Embryology. (To be given 1918.) The rôle of external factors in development. C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

Special Research

Zoology 227-228—Investigation of special problems in any of the subjects enumerated above. Variable. Not in general counted as part of course-work.

Courses in Summer Session and Extension Teaching: Columbia

Zoology s1—Elementary Biology and Zoology. Lectures and laboratory work. Credit I. 4 points. Professor MCGREGOR.

Prerequisite: Natural Science A, or Elementary Chemistry, or Physics.

NOTE: This course is not the exact equivalent of *Zoology 1*. Although elementary, it is not sufficiently simple to be adapted to the needs of high school pupils.

In the requirements for the Medical School the above courses will supplement *Botany s2-s2a*. The class will be limited to forty students.

Zoology s121—Protozoology. Lectures, demonstrations, and laboratory work amounting to not less than twenty-four hours per week. Credit IA, II. 5 points. Professor CALKINS.

Courses in Extension Teaching: Long Island College Hospital

Zoology e1-2—Elementary Biology and Zoology. Lectures and laboratory. 6 points each session. Professor CALKINS, Mr. ELWYN, and Mr. PERKINS.

Zoology e3—General Embryology. 3 points. Mr. ELWYN.
Given in Winter Session of 1918, alternating with e7.

Zoology e4—Advanced Biology. 3 points. Professor CALKINS.
Given in Spring Session, 1918, alternating with e8.

Zoology e5-6—Vertebrate Comparative Morphology. 3 points each session. Mr. ELWYN.

Zoology e7—Histological Technique. 3 points. Mr. ELWYN.
Given in Winter Session, 1919, alternating with e3.

Zoology e8—Human Parasitology. 3 points. Professor CALKINS.
Given in Spring Session, 1919, alternating with e4.

Courses in Biometrical Methods

Anthropology 121—Anthropometry—Biometrical Methods. C, 2 hours. 6 points. Professor BOAS.

This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the inter-

relations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged.

Anthropology 122—Anthropometry—Growth. C, 2 hours. 3 points
Professor BOAS.

A discussion of the phenomena of growth with special relation to the influences of heredity and of environment.

Courses under the George Crocker Special Research Fund

Zoology 202—General Biology of Tumors. 4 points. Professor WOGLÖM
Prerequisite: Mammalian histology.

Zoology 205-206—Research in Problems of Growth Pathology with Especial Reference to Tumors. Credit to be assigned in individual cases at the time of registration. 4-12 points each session. Professors WOOD and WOGLÖM and Drs. PRIME and BULLOCK.

The laboratories of the George Crocker Special Research Fund are open to properly qualified workers for research in pathology under the supervision of the Director of Cancer Research.

Zoology 209—Morphology and Classification of Tumors, including Pathological Technique. 4 points. Professor WOOD.

Prerequisite: Mammalian histology.

Course in the College of Pharmacy

A laboratory course of 200 hours in the general biology of plants and animals is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

Course in the College of Physicians and Surgeons

Zoology 101—Histology and Embryology. 12 hours. 8 points.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors BIGELOW and BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in the current *Announcement of Teachers College, School of Education*.

ACADEMIC CALENDAR 1918-1919

1918

July 8, Monday. **Nineteenth Summer Session begins.**

Aug. 1, Thursday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October. The privilege of later application may be granted up to August 15 on payment of a fee of \$5. Last day for filing applications for deficiency and special examinations. The privilege of later application may be granted on payment of a fee of \$5.

Aug. 16, Friday. **Nineteenth Summer Session ends.**

Sept. 9, Monday. Last day for filing applications for entrance examinations, and for advanced standing. The privilege of later application may be granted on payment of a fee of \$5.

Sept. 16, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.

Sept. 18, Wednesday. **Registration** (including the payment of fees) **begins.**

Sept. 24, Tuesday. Registration ceases for students previously matriculated except graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$5.

Sept. 25, Wednesday. **Winter Session, 165th year, begins.** Registration ceases for stu-

dents not previously matriculated, except graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$5.

Sept. 28, Saturday. Registration ceases for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts. The privilege of later application may be granted up to October 19 on payment of a fee of \$5.

Oct. 1, Tuesday. Last day for filing essay for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October. Last day for filing applications for all degrees to be conferred in October, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5. Last day for making changes in program, except for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts.

Oct. 15, Tuesday. Stated meeting of University Council.

Oct. 19, Saturday. Last day for receiving late applications for registration and for making changes in program for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts.

Nov. 5, Tuesday. Election Day, holiday.

Nov. 27, Wednesday. **Annual Thanksgiving Service** in St. Paul's Chapel.

Nov. 28, Thursday, to November 30, Saturday, inclusive. Thanksgiving holidays.

Dec. 2, Monday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in February. The privilege of later application may be granted up to December 14 on payment of a fee of \$5.

Dec. 8, Sunday. **Annual Commemoration Service** in St. Paul's Chapel.

Dec. 17, Tuesday. Stated meeting of University Council.

Dec. 23, Monday, to

1919

Jan. 4, Saturday, inclusive. Christmas holidays.

Jan. 9, Thursday. Last day for filing applications for entrance examinations. The privilege of later application may be granted on payment of a fee of \$5.

Jan. 16, Thursday. Mid-year entrance examinations begin.

Jan. 22, Wednesday. Mid-year examinations begin.

Feb. 1, Saturday. **Registration** (including the payment of fees) **begins**. Last day for filing applications for all degrees to be conferred in February, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later appli-

cation may be granted on payment of a fee of \$5.

Feb. 4, Tuesday. **Winter Session ends**. Last day for filing essay for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in February.

Registration ceases for students entering Spring Session. The privilege of later registration may be granted up to March 1 for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts on payment of a fee of \$5.

Feb. 5, Wednesday. **Spring Session begins**. **University Service** in St. Paul's Chapel.

Feb. 12, Wednesday. Alumni Day.

Feb. 15, Saturday. Last day for making changes in program, except for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts.

Feb. 18, Tuesday. Stated meeting of University Council.

Feb. 22, Saturday. Washington's Birthday, holiday.

Mar. 1, Saturday. Last day for receiving late applications for registration and for making changes in program for graduate students in Political Science, Philosophy, Pure Science, Education and Practical Arts. Last day for filing applications for University Fellowships and Scholarships.

Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be

conferred in June. The privilege of later application may be granted up to March 15 on payment of a fee of \$5.

Apr. 1, Tuesday. Last day for filing applications for examination for the degree of Doctor of Philosophy to be conferred in June.

Apr. 15, Tuesday. Stated meeting of University Council.

Last day for filing applications for all degrees to be conferred in June, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.

Apr. 17, Thursday, to April 21, Monday, inclusive. Easter holidays.

Apr. 21, Monday. Last day for filing applications for deficiency and special examinations. The privilege of later application may be granted on payment of a fee of \$5.

May 1, Thursday. Last day for students in Columbia College to file choice of studies for following year. The privilege of filing such choice later may be granted on payment of a fee of \$5.

Last day for filing applications for scholarships in the Schools of Law, Applied Science, and Architecture.

May 19, Monday. Final examinations begin.

May 21, Wednesday. Last day for filing essays for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in June.

May 30, Friday. Memorial Day, holiday.

June 1, Sunday. **Baccalaureate Service.**

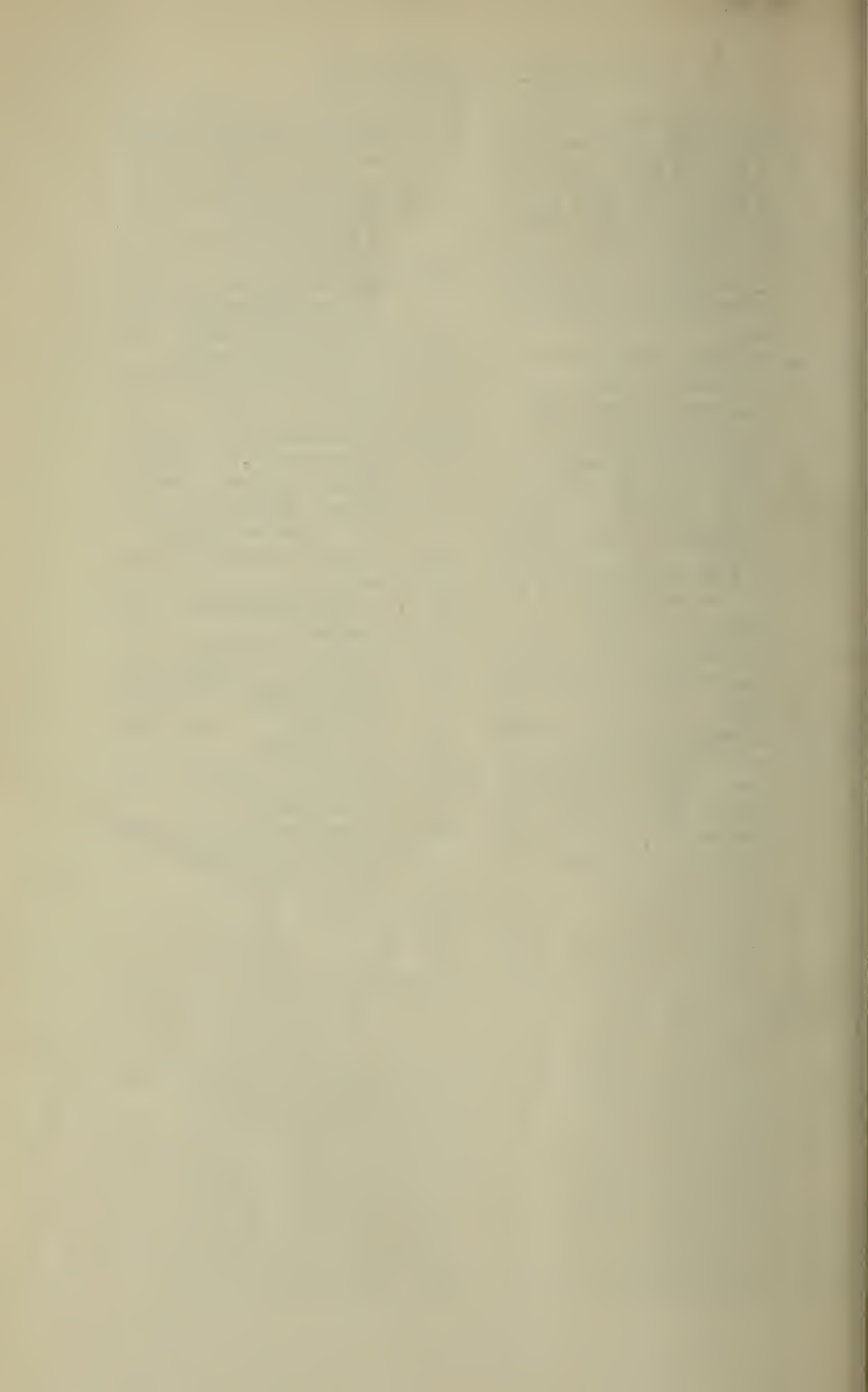
June 2, Monday. Class Day.

June 4, Wednesday. **Commencement Day.**

June 11, Wednesday. **Spring Session ends.**

June 16, Monday. Entrance examinations begin.

July 7, Monday. **Twentieth Summer Session begins.**



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1919/20

Nineteenth Series, No. 34

July 14, 1919



Columbia University Bulletin of Information

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DIVISION OF BIOLOGY

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COLOGY, PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1919-1920

UNIVERSITY OF ILLINOIS

JUN 1-6 1919

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Columbia University Bulletin of Information

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1. Annual Reports of the President and Treasurer to the Trustees.
2. The Catalogue of the University, price twenty-five cents, and the Announcements of the several Colleges and Schools, and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University.

A.P.-2,000-1919.

OFFICERS OF THE DIVISION OF BIOLOGY

GEORGE S. HUNTINGTON *Professor of Anatomy, Executive officer,
Department of Anatomy*
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D., Jefferson Medical College, 1907.

HENRY FAIRFIELD OSBORN *Research Professor of Zoology*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901; Princeton, 1902; Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.) Christiania, 1911; Member of National Academy of Sciences.

EDMUND B. WILSON *Da Costa Professor of Zoology, Executive officer,
Department of Zoology*
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902; LL.D., Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.), Leipsic, 1909; Member of National Academy of Sciences.

FREDERIC S. LEE *Dalton Professor of Physiology, Executive officer,
Department of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; Ph.D., Johns Hopkins, 1885.

BASHFORD DEAN *Professor of Vertebrate Zoology*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D., 1890; Chevalier de la Légion d'Honneur, 1910.

HENRY E. CRAMPTON *Professor of Zoology*
A.B., Columbia, 1893; Ph.D., 1899.

WILLIAM J. GIES *Professor of Biological Chemistry, Executive officer,
Department of Biological Chemistry*
B.S., Pennsylvania College, 1893; M.S., 1896; Sc.D., 1914; Ph.B., Yale, 1894; Ph.D., 1897.

HERBERT MAULE RICHARDS . . . *Professor of Botany and Secretary of the Division*
B.S., Harvard, 1891; Sc.D., 1895.

¹GARY N. CALKINS *Professor of Protozoology*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898.

MAURICE A. BIGELOW *Professor of Biology in Teachers College*
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.

RUSSELL BURTON-OPITZ *Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.

THOMAS HUNT MORGAN *Professor of Experimental Zoology*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; LL.D., 1915; Member of National Academy of Sciences.

BERN B. GALLAUDET *Assistant Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.

JOHN HENRY LARKIN *Assistant Professor of Pathology*
A.B., Manhattan, 1891; M.D., Columbia, 1894.

¹ Absent on leave, Spring Session.

- JAMES HOWARD MCGREGOR *Associate Professor of Zoology*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- CARLTON CLARENCE CURTIS *Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1893; A.M., Columbia, 1892.
- ¹TRACY E. HAZEN *Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- ROBERT A. HARPER *Torrey Professor of Botany, Executive officer,*
Department of Botany
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences
- ¹FRANK HENRY PIKE *Associate Professor of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- CHARLES C. LIEB *Assistant Professor of Pharmacology, Executive officer,*
Department of Pharmacology
A.B., Columbia, 1902; M.D., 1906.
- HANS ZINSSER *Professor of Bacteriology, Executive officer,*
Department of Bacteriology
A.B., Columbia, 1899; A.M. and M.D., 1903.
- ALWIN M. PAPPENHEIMER *Associate Professor of Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY *Professor of Neurology and Neuro-Anatomy*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- JEAN BROADHURST *Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908; Ph.D., Cornell, 1914.
- HORATIO B. WILLIAMS *Assistant Professor of Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- WILLIAM K. GREGORY *Assistant Professor of Vertebrate Palæontology*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- LOUISE HOYT GREGORY *Assistant Professor of Zoology in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- VERA DANSCHAKOFF *Assistant Professor of Anatomy*
M.D., Lausanne, 1902; M.D., Charkow, 1903; Petrograd Academy of Medicine, 1907.
- JAMES W. JOBLING *Professor of Pathology*
M.D., Tennessee Medical College, 1897.
- CHARLES H. BAILEY *Associate in Pathology*
A.B., Brown, 1903; M.D., Harvard, 1910.
- RICHARD H. CUNNINGHAM *Associate in Physiology*
M.D., Medical College of Virginia, 1886; M.D., Columbia, 1888.
- JAMES G. DWYER *Associate in Bacteriology*
A.M., Queen's, 1902; M.D., 1905; Ph.D., Columbia, 1918.
- ANDREW A. EGGSTEIN *Associate in Pathology*
B.S., Dickson, 1908; M.D., Vanderbilt Medical College, 1912.

¹ Absent on leave, Spring Session.

- ADOLPH ELWYN *Associate in Anatomy*
B.S., Columbia, 1915; A.M., 1917.
- FREDERICK G. GOODRIDGE *Associate in Biological Chemistry*
A.B., Howard, 1897; M.D., Columbia, 1901; Ph.D., 1915.
- EDGAR G. MILLER, Jr. *Associate in Biological Chemistry*
B.S., Gettysburg, 1911; Ph.D., Columbia, 1913;
- ERNEST L. SCOTT *Associate in Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911; Ph.D., Columbia, 1914.
- JOHN C. VAUGHAN *Associate in Anatomy*
M.D., Columbia, 1907.
- JOSEPH S. WHEELWRIGHT *Associate in Physiology*
A.B., Yale, 1897; M.D., Cornell, 1900.
- BERNARD O. DODGE *Instructor in Botany*
Ph.B., Wisconsin, 1909; Ph.D., Columbia, 1912.
- HATTIE L. HEFT *Instructor in Physiological Chemistry*
Teachers College
B.S., Louisville, 1912; M.S., 1913; A.M., Columbia, 1914; Ph.D., 1917.
- FLORENCE DEL. LOWTHER *Instructor in Zoology in Barnard College*
A.B., Columbia, 1912; A.M., 1915.
- HERMANN J. MULLER *Instructor in Zoology*
A.B., Columbia, 1910; A.M., 1911.
- HESTER M. RUSK *Instructor in Botany in Barnard College*
A.B., Columbia, 1912; A.M., 1917.
- CAROLINE STACKPOLE *Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- MARION E. RICHARDS *Lecturer in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- CORNELIA L. CAREY *Assistant in Botany in Barnard College*
- HELEN C. COOMBS *Research Assistant in Physiology*
A.B., Columbia, 1911; B.S., 1914; A.M., 1915; Ph.D., 1918.
- SAMUEL C. DELLINGER *Assistant in Zoology*
A.B., Trinity (N. C.), 1915.
- ALFRED F. HUETTNER *Assistant in Zoology*
A.B., South Dakota, 1916; A.M., Columbia, 1918.

MEMBERS OF THE STAFF OF THE BOTANICAL GARDEN GIVING
INSTRUCTION IN THE DIVISION

- NATHANIEL LORD BRITTON, Ph.D., Sc.D. *Director*
- WILLIAM ALPHONSO MURRILL, Ph.D. *Assistant Director*
- ARLOW BURDETTE STOUT, Ph.D. *Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D. *Head Curator of the Museums*
- FRED. JAY SEAVER, Ph.D. *Curator*
- PER AXEL RYBERG, Ph.D. *Curator*
- MARSHALL AVERY HOWE, Ph.D. *Curator*
- GEORGE VALENTINE NASH *Curator of the Plantations*
- HENRY HURD RUSBY, M.D. *Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D. *Consulting Chemist*

Partial courses are also given by

ELIZABETH GERTRUDE BRITTON

EDWARD SANFORD BURGESS, Ph.D.

UNIVERSITY OFFICERS OF ADMINISTRATION

WILLIAM H. CARPENTER, Ph.D.	<i>Provost of the University</i>
FRANK DIEHL FACKENTHAL, A.B.	<i>Secretary of the University</i>
EDWARD J. GRANT, A.B.	<i>Assistant Registrar of the University</i>
CHARLES S. DANIELSON	<i>Bursar of the University</i>
HENRY L. NORRIS, M.E.	<i>Superintendent of Buildings and Grounds</i>
REV. RAYMOND C. KNOX, S.T.D.	<i>Chaplain of the University</i>
GEORGE L. MEYLAN, M.D.	<i>Medical Director of the Gymnasium</i>
WILLIAM H. McCASTLINE, M.D.	<i>University Medical Officer</i>

GENERAL STATEMENT

The Division of Biology includes the following departments, Anatomy, Bacteriology, Biological Chemistry, Botany, Pathology, Pharmacology, Physiology, and Zoology, which offer courses of study leading to university degrees. This bulletin is designed primarily for advanced students and for candidates for the degrees of Master of Arts and Doctor of Philosophy. Other students should consult the Announcements of Columbia College, Barnard College, Extension Teaching, College of Physicians and Surgeons, Teachers College, School of Education and Practical Arts, which may be had from the Secretary of the University.

The university requirements for the degrees of Master of Arts and Doctor of Philosophy are stated in full in the Announcement of the Faculties of Political Science, Philosophy and Pure Science, which will be sent upon application to the Secretary of the University. This Announcement contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments, university and tuition fees, and all other university matters of interest to advanced students. Special departmental requirements for the degrees of Master of Arts and Doctor of Philosophy are stated under the separate departmental headings.

Women are admitted to certain courses in the Division, as indicated in the departmental statements. The conditions of entrance are the same as those for men.

Funds and Prizes. Graduates of the School of Medicine compete annually for either the Alumni Association or the Cartwright Prize, each amounting to \$500, to be awarded for the best medical essay, the latter prize being open to universal prize competition. These prizes are open, therefore, to students of the division. The Stevens Triennial Prize, amounting to \$200, is also awarded for the best medical essay, and is open to general competition.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy. The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology. The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media. The labora-

tories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

Biological Chemistry (Nutrition). At the College of Physicians and Surgeons the Department of Biological Chemistry possesses eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor GIES' library occupies a room adjoining the laboratory and is accessible by appointment and to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoological Park for research, under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany. The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

Special laboratories are devoted to work in general and cellular physiology and are provided with micro-photographic equipment and a Zeiss ultraviolet microscope. All necessary apparatus and reagents are available for general histological and cytological work. Provision is also made for work on the metabolism of cells and their reactions to physical stimuli. The equipment includes apparatus for the study of the effects of various thermal, light, and gravitational stimuli on protoplasmic activities, a photometer and electrical measuring instruments, such as a delicate d'Arsonval galvanometer, mil-ammeters, resistance-measuring instruments, etc., for the study of electro-physiological problems.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus, affords facilities for experimental work in physiology and pathology, and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing the fungi and algæ in pure cultures is also available.

Under agreement with the University, the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment, and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic

collections are in special rooms. Ample opportunity for experimental work in plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses.

The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

A seminar for the study of special subjects in general physiology meets weekly, and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a bi-weekly colloquium.

Pathology. The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, amphitheater, photographic rooms, etc., on the fifth floor. On the fourth floor, there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, several specially equipped operating rooms for aseptic experimental work, a clinical laboratory, the museum, preparation rooms, cold storage, etc. Two rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used both for the instruction of medical students and as a place of deposit for specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology. The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises two laboratories, which are provided with special apparatus for teaching purposes; six laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, mainly for research; a library containing sets of the physiological journals, monographs, and other books, and many reprints of special articles; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. Skilled mechanics give their entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the department has the use of a laboratory equipped for the instruction of undergraduates.

Zoology. The zoological laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoology, and eight rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room. The laboratories are well equipped with optical instruments, microtomes, and other apparatus for advanced work.

Owing to the accessibility of the collections of the American Museum of Natural History (see below), the department does not maintain a general zoological

museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, charts and wax models, and an aquarium room.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works, and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoology and palæontology of invertebrates and vertebrates, both from the systematic and bionomic points of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoological Park in the Borough of the Bronx, under the direction of the New York Zoological Society, affords exceptional opportunities for the study of living reptiles, birds, and mammals.

The New York Aquarium, also under the management of the Zoological Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets every week in the department library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

The Marine Biological Laboratories at Woods Hole, Massachusetts, and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, five investigators' rooms (ten tables) are subscribed for by the University for the use of the Department of Zoology; in the latter, a table is available through the John D. Jones Scholarship. The University also maintains an investigators' table at the Naples Zoological Station.

Publications by Members of the Division. The Columbia University Press issues the *Columbia University Biological Series*, of which ten volumes have already appeared.

The Department of Physiology issues *Studies from the Department of Physiology*, of which six volumes have already appeared.

ANATOMY

Anatomy 101—Histology and Embryology. Lectures, conferences, and laboratory work. 12 hours. 8 points. Professors HUNTINGTON and DANSCHAKOFF and Mr. ELWYN and staff.

Anatomy 103-104—Anatomy of the Extremities; Preliminary Visceral Anatomy. Demonstrations, conferences, and dissections. 12 hours. 8 points each session. Professor GALLAUDET, Dr. VAUGHAN, and staff.

Anatomy 105—Anatomy of the Head and Central Nervous System; Abdomen and Thorax. Demonstrations, conferences, laboratory work, and dissection. 12 hours. 6 points. Professor GALLAUDET, Dr. VAUGHAN, and staff.

Anatomy 107—Vertebrate Morphology, Anatomy of the Body Cavities, Visceral Topographical Course, Thorax and Abdomen. Lectures combined with demonstrations. 3 hours. 3 points. Professor HUNTINGTON.

BACTERIOLOGY

Preliminary Statement

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. They should fulfil the requirements exacted of candidates for entrance to the medical school. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may be secured in Course 1 in general inorganic chemistry in the Department of Chemistry, and in Course 2 in elementary zoology in the Department of Zoology.

For the degree of Master of Arts the student must include among the courses he elects Courses 201, 205, 206, and 208. An essay based on work of a research nature or a critical review is also required.

For admission to candidacy for the Ph.D. degree, the student must be able to read French and German, must have done the work in Courses 201, 205, 206, and 208, and must be recommended by the department as able to undertake research.

Courses 201 and 203, 205-206, 208, 211-212, 251-252 are open to women.

Bacteriology 101—General Bacteriology, especially adapted to the requirements of students of medicine. Six hours a week for one-half of the academic year; given in the Department of Bacteriology under the Medical Faculty. 5-6 points. Professor ZINSSER and Dr. DWYER.

Bacteriology 201—Advanced Bacteriology. The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon, in October, November, December, and January. 9 points. Dr. DWYER and assistants.

This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identification of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants, and of germicides.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*, Macé's *Bacteriologie*.

Bacteriology 203-204—Special Bacteriology. Rating individually determined for each case at the time of registration. 6 to 18 hours laboratory. 3-9 points. Dr. DWYER and assistants.

As under Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; and the pursuit of some selected theme for original investigation.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*.

Attendance and hours individually arranged.

Bacteriology 205—The Principles of Infection, Immunity, Serum Diagnosis, and Therapy. Lectures with demonstrations. 1 hour. 1 point. Dr. OTTENBERG.

Text-book: Zinsser, *Infection and Resistance*.

Bacteriology 208—A Practical Laboratory Course in the Technique of Serum Study. 6 hours; second half-year; limited to twenty students. 6 points. Prerequisites: 201 and 205.

Bacteriology 209-210—Clinical Bacteriology. Dr. DWYER. Rating individually determined at time of registration.

A course will be given at the laboratory of the Manhattan Eye, Ear, and Throat Hospital in which a small group of students will be taught the methods of examining material from patients suffering from infections chiefly of the eye, ear, nose, and throat, and course will include the bacteriological diagnosis of material, the making of blood cultures, the making of autogenous vaccines and their use in the treatment of patients, etc.

Bacteriology 211 or 212—Clinical Serology. 3 points. Dr. OTTENBERG and assistants.

Technique of Wassermann reaction and other clinical serum reactions. Laboratory open to properly qualified graduate students, to physicians and to undergraduates who have taken courses 205-206 and 208 or equivalent.

Bacteriology 251-252—Research in Bacteriology. 2 to 8 points each session. Under the direction of the professor of bacteriology.

Rating individually determined at the time of registration.

Summer Session

Bacteriology s101—General Bacteriology. 5 to 6 points, equivalent to Course 101. Dr. DWYER.

Course in Barnard College

Botany 151-152—Bacteria and Ferment Fungi. C, 2 hours; L, 6 hours. 5 points. Professor RICHARDS and Miss RUSK.

Course in Teachers College

For details of a course in bacteriology applied to household arts given in Teachers College by Professor BROADHURST, see the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

For details of a laboratory course of thirty-two hours in Bacteriology, given in the College of Pharmacy, see the separately printed *Announcement of the College of Pharmacy*.

BIOLOGICAL CHEMISTRY

(Nutrition)

Courses in Nutrition (Physiological and Pathological Chemistry)

Biological Chemistry 101 or 102—General Physiological Chemistry. C, 1 hour; L, 7 hours. 5 points. Professor GIES and assistants.

[The equivalent of this course is given at Teachers College in the School of Practical Arts (H A 127), by Professor GIES and Dr. HEFT.]

A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes.

Biological Chemistry 202—Advanced Physiological Chemistry, including Methods of Research in Nutrition. (Teachers College, School of Practical Arts.) C, 1 hour; L, 6 hours. 4 points. Professor GIES and Dr. HEFT.

Biological Chemistry 211-212—Biochemical Methods of Research, including Clinical Methods. C, 1 hour; L, 7 hours. 5 points each session. Dr. MILLER.

Biological Chemistry 221-222—Nutrition in Health (advanced physiological chemistry). C, 2 hours; L, 14 hours. 8 points each session. Professor GIES.

Biological Chemistry 251-252—Advanced Physiological and Pathological Chemistry, including all phases of nutrition. Research 20 hours. 8 points each session. Professor GIES.

Toxicological Chemistry

Biological Chemistry 261-262—Effects and Detection of Poisons, including Food Preservatives and Adulterants. L, 10 hours. 5 points each session. Professor GIES.

Botanical Chemistry

Biological Chemistry 271-272—Chemical Physiology of Plants. C, 1 hour; L, 7 hours. 5 points each session. (The course may be taken in whole or in part at the New York Botanical Garden, where Professor GIES is consulting chemist.) See Botany, below. Professor GIES and assistants.

Bacteriological Chemistry

Biological Chemistry 281-282—Chemistry of Micro-organisms; Fermentations, Putrefactions, Enzyme Actions in General (introduction to sanitary chemistry). C, 1 hour; L, 7 hours. 5 points each session. Professor GIES and assistants.

Seminar

301-302. The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department, meet weekly to discuss results of recent researches in chemical biology. 1 hour. No course credit. Professor GIES.

Summer Session

For details of the work in Biological Chemistry offered in the Summer Session see the separately printed *Announcement of the Summer Session*.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings, which are open to all students in the University. It also issues the quarterly *Biochemical Bulletin* now in its sixth volume.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant psychology and morphology and a good knowledge of microscopic technique. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4, and 101-102 for men or Courses 51-52, 53-54, 153 and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

All graduate courses are open to women.

For the degree of Master of Arts the Department of Botany requires that the candidate shall complete, first, a specified number of formal courses with examinations and, second, the investigation of an assigned problem with a written report on the work done.

Matriculated candidates for the degree of Doctor of Philosophy are required by the department to have as a preliminary a reading knowledge of French and German.

In addition to the thesis embodying the results of research and the courses required for the major subject, the candidate is required to complete research work or a specified number of courses in two minor subjects, one of which must be chosen outside the department. The departmental recommendation for the degree is based on the major and minor work, the completion of the thesis and the final examination.

The proportionate amount of time to be devoted to course work and research and the choice of the courses and the problem will be determined on consultation with the member of the staff with whom the research work is to be done.

A. Undergraduate Courses

Botany 1-2—General Botany. C, 2 hours; L, 4 hours. 4 points each session. Professor CURTIS.

Botany 3-4—Plant Morphology. C, 2 hours; L, 4 hours. 4 points each session. Professor CURTIS and Dr. DODGE.

Botany 5—Elementary Plant Pathology. C, 1 hour; L, 3 hours. 3 points. Dr. DODGE.

Botany 6—Economic Botany. C, 1 hour; L, 3 hours. 3 points. Dr. DODGE.

Botany 7—Growth and Character of Timber. C, 1 hour; L, 3 hours. Professor CURTIS.

Botany 9-10—Botanical Problems. Introductory to research. Professors HARPER and CURTIS.

B. Graduate Courses

Botany 103-104—Structure and Development of Plants. A general survey of the plant kingdom from the standpoint of structure and phylogeny. 3 or 5 points each session. Professor CURTIS and Dr. DODGE.

Botany 113-114—Advanced Morphology. I. Organography and development of plants. II. Evolution of Angiosperms. Course I given in 1919-1920. 3 or 5 points each session. Professor CURTIS.

Botany 115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause diseases of plants. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Botany 117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Botany 121-122—Advanced Morphology. Bryophyta and Pteridophyta. 3 or 5 points each session. Professor HARPER and Dr. DODGE.

Prerequisite: *Botany 103-104.*

C. Advanced Graduate and Research Courses

Hours and credit for courses in research (**Botany 200 to 244**) are arranged on consultation and should be recorded at the office of the Registrar.

Botany 201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritabile mechanism of the plant, and the permanent adaptive reactions to environmental factors. 4 or 8 points each session. Professors RICHARDS and CURTIS.

Botany 209-210—Physiology of Nutrition. Treated from a chemical standpoint. 4 or 8 points each session. Professors RICHARDS and GIES.

Botany 211-212—Plant Pathology. Diseases induced by cryptogamic parasites, including work in culture methods. 4 or 8 points each session. Professor HARPER and Drs. MURRILL, SEAVER, and DODGE.

Botany 217-218—Embryology of Spermatophyta. With special work during two summers. 4 or 8 points each session. Professors CURTIS and HAZEN.

Botany 219-220—Morphology. Work dealing with morphological problems in the various groups of plants. 4 or 8 points each session. Directed by members of the department and Botanical Garden staff.

Botany 227-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. 4 or 8 points each session. Directed by members of the Botanical Garden staff.

Botany 235-236—Plant Distribution. Problems dealing with regional botany or plant geography. 4 or 8 points each session. Professor BRITTON and other members of the staff.

Botany 241-242—Research on the Physiology of the Cell and Reproduction. 4 or 8 points each session. Professor HARPER.

Botany 243-244—Plant Breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. 4 or 8 points each session. Dr. STOUT.

Botany 301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. 2 points each session. Professor HARPER.

Colloquium. A bi-weekly meeting for the discussion of current botanical literature.

Conference. A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Botany 51-52—Principles of Plant Morphology and Physiology. C, 2 hours; L, 4 hours. 8 points. Professor RICHARDS, Miss RUSK (Barnard), and Miss CAREY.

Botany 53-54—General Morphology and Development of Plants. C, 2 hours; L, 4 hours. 8 or 10 points. Professor HAZEN and Miss H. M. RUSK.

Botany 55-56—Morphology and Classification of Spermatophytes. Study of the Natural Orders. C, 1 hour; L, 4 or 6 hours. 3 or 4 points. Professor HAZEN.

[**Botany 58—Principles of Agriculture.** C, 2 hours; L, 4 hours. 4 points. Miss RUSK. Not given in 1919-1920.]

Botany 151-152—Bacteria and Ferment Fungi. C, 2 hours; L, 6 hours. 3 or 5 points. Professor RICHARDS and Miss RUSK.

Botany 153—Anatomy of Vascular Plants. C, 2 hours; L, 6 hours. 3 or 5 points. Mrs. RICHARDS (Barnard).

Botany 154—Physiology of Plants from Standpoint of Nutrition. C, 2 hours; L, 6 hours. 5 points (C only 3 points). Professor RICHARDS and Mrs. RICHARDS (Barnard).

Botany 157—Embryology and Laboratory Methods. Practice in methods of technique, with the study of the embryology of one or more types. L, 8 hours with occasional lectures and outside reading. 4 points. Professor HAZEN.

Botany 158—Structure and Development of Algæ. Advanced Course. C, 1 hour; L, 6 hours. 4 points. (Not given 1919-1920.) Professor HAZEN.

Botany 159—Structure and Development of Fungi. Advanced course. C, 1 hour; L, 6 hours. 4 points. Professor RICHARDS.

Botany 161-162—Advanced Physiology and Morphology. Work will be arranged to suit the needs of the students. 4 or 8 points. Professors RICHARDS and HAZEN and Mrs. RICHARDS (Barnard).

Summer Session and Extension Teaching

(See separately printed announcements)

Courses in Teachers College

Courses dealing with the teaching of botany open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors BIGELOW and BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in the current *Announcement of Teachers College*.

Courses in the College of Pharmacy

A course of thirty lectures, thirty recitation hours, and seventy-five hours laboratory work in structural and descriptive botany; a laboratory course of ninety hours in botany applied to the study of drugs; and a course of thirty hours in plant classification are given in the College of Pharmacy.

Courses in Biometrical Methods

See page 23

PATHOLOGY

Pathology 102—General and Specific Pathology. C, 3 hours; L, 6 hours. 2 points each session. Officers of the department.

Pathology 106—Gross Pathological Anatomy and Attendance upon Autopsies. 1 point. Officers of the department.

Pathology 107—Experimental Pathology. 3 hours. 2 points. Limited to twelve students. Officers of the department.

Pathology 110—Case Study of Autopsy Material. At the Presbyterian Hospital; 3 hours; Spring Session, second year. Groups limited to twelve men. Hours to be arranged. The officers of the department.

Pathology 201-202—Advanced Pathology. The officers of the department.

Credit for this course varies from 2-8 points each session, according to arrangements made at the time of registration by the student with the instructor and recorded at the office of the Registrar.

Pathology 251-252—Research in Pathology. 6-10 points each session. Under the direction of the professor of pathology. The officers of the department.

Credit for this course varies from one half-course to two double courses, according to the arrangement made at the time of registration by the student with the instructor.

See also additional courses listed under George Crocker Special Research Fund on page 23.

PHARMACOLOGY

Pharmacology 213-214—General Pharmacology. Lectures, 1 hour; laboratory work, 6 hours. 4 points each session. Professor LIEB.

Pharmacology 215—Biological Standardization of Drugs. Laboratory work, 7 hours; first half-year. 3 points. Professor LIEB.

The Department of Pharmacology occupies the eastern section of the third floor of North building of the College of Physicians and Surgeons. It comprises

a laboratory for undergraduate instruction in pharmacology and pharmacy, three research laboratories, a chemical laboratory, and a well-equipped shop. The laboratories are supplied with all apparatus necessary for the investigation of pharmacological problems.

PHYSIOLOGY

Students who are candidates for one of the graduate degrees with physiology as their primary choice should have some knowledge of physics, chemistry, and biology. The specific requirements for the degree depend, in part, upon the previous preparation of the candidate, and he should always confer with the executive officer of the department before entering upon his work. A candidate for the degree of Master of Arts who has had no previous work in physiology is expected to take either Physiology 106-107 or Physiology 201-202 and 203-204, together with such other work as the department may prescribe.

Physiology 2—Elementary Physiology. C, 2 hours; L, 4 hours. 3 points.

Physiology 106-107—Human Physiology. Lectures 3 hours; demonstration 2 hours; recitations 2 hours; laboratory work 5 hours. 8 points each session. Professor BURTON-OPITZ and Drs. BENDER and LEBER.

Physiology 108—Physics of X-Rays. Lectures with demonstrations 1 hour; eight weeks. 1 point.

Physiology 201-202—General Physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each session. Professor PIKE.

Physiology 203-204—Special Physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each session. Professors BURTON-OPITZ and PIKE.

Physiology 205-206—Problems of Evolution from the Standpoint of Physiology. Lectures 1 hour. 1 ½ points each session. Professor PIKE.

Physiology 207—Clinical Physiology. The application of physiological methods to the problems of clinical medicine. Lectures and demonstrations 2 hours, first half-year. Professors BURTON-OPITZ and PIKE.

Physiology 208—Principles of electro-cardiography. Lectures with demonstrations; 1 hour; eight weeks. 1 point.

Physiology 251-252—Research in Physiology. Under the direction of Professor LEE. The officers of the department. Hours to be arranged.

Credit for this course varies according to the arrangement made at the time of registration by the student with the instructor.

Courses in Barnard College

A course in general Animal Physiology is given by the Department of Zoology of Barnard College, supplementing the work in general Biology and Zoology. See page 16 and the separately printed *Announcement of Barnard College*.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College: One dealing with Plant Nutrition, Botany 154, a second with Growth, Botany 156, a third with advanced problems in Physiology, Botany 161-162. Professor RICHARDS and Mrs. RICHARDS. See page 16 and the separately printed *Announcement of Barnard College*.

Summer Session

For information in regard to the courses in Physiology offered by Professor BURTON-OPITZ in the Summer Session, see the separately printed *Announcement of the Summer Session*.

Courses in Teachers College

The Department of Physical Education of Teachers College offers Physical Education 55-56, Applied Physiology. Professor BURTON-OPITZ.

The courses in Applied Biology given in Teachers College are chiefly physiological. Professors BIGELOW and BROADHURST and Miss STACKPOLE. For details consult the separately printed *Announcement of Teachers College, School of Practical Arts*.

Course in the College of Pharmacy

A course of thirty lectures and thirty recitations in Human Physiology is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

University Extension

A course of forty lectures in Elementary Physiology is given under the auspices of the Department of Oral Hygiene. Professor BURTON-OPITZ.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, p. 15. 201-202, Advanced Physiology (Professors RICHARDS, CURTIS); 209-210, Physiology of Nutrition (Professors RICHARDS and GIES).

ZOOLOGY

Graduate work in zoology requires at least two years of preparatory undergraduate study or the equivalent, *i. e.*, an acquaintance with the general principles of biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology, and microscopical technique. Such a preparation is afforded by Courses 1-4, 51, 91-92, and 93 or 95-96. For students whose main interest lies in other subjects less extensive preparations may suffice, but such students must have taken at least one year's work in zoology or elemental biology. Courses numbered below 100 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a high standard of scholarship and of training, as shown particularly by the doctor's dissertation. Candidates are, however, expected to attend such courses as the department may recommend, which may include courses in other departments. For the degree of Master of Arts in Zoology at least sixteen of the thirty tuition points prescribed by the University regulations must be taken in the Department of Zoology, together with such other work as the department may require. For the degree of Doctor of Philosophy it is in practice usually found desirable to attend additional courses aggregating at least thirty tuition points.

For either degree specially assigned study or research (to be registered as Course 227-228) may in part, with the approval of the department, take the place of formal course-work. To Ph.D. students whose main work is in Zoology, Courses 201, 215-216, 221-222, 223-224, and 225-226 are suggested as a general foundation.

All the graduate courses are open to women.

A. Undergraduate Courses

Zoology 1-2—Elementary Biology (Zoology). C, 2 hours; L, 4 hours. 4 points each session. Professors CALLINS and MCGREGOR, Dr. MULLER (Columbia College); Professors CRAMPTON and L. H. GREGORY, Mrs. LOWTHER (Barnard College).

Zoology 3—Elementary Histology. 1 hour. Mrs. LOWTHER (Barnard College).

Zoology 4—Elementary Embryology. C, 1 hour; L, 2 hours. 2 points. Professor MORGAN (Columbia College); Professor CRAMPTON, Mrs. LOWTHER (Barnard College).

Zoology C—Human Biology. C, 2 hours. Professors CRAMPTON and GREGORY and Dr. ALSOP (Barnard College).

Zoology 53-54—Practical Zoology and Embryology. 2 points. Mrs. LOWTHER (Barnard College).

Zoology 91-92—General Zoology. C, 2 hours; L, 6 hours. Professor MCGREGOR (Columbia College).

Zoology 93—Comparative Embryology of Vertebrates. C, 1 hour; L, 2-5 hours. Professor MCGREGOR (Columbia College).

Zoology 95-96—Comparative Morphology of Vertebrates. C, 1 hour; L, 4 hours. 3 points each session. Professor MCGREGOR.

Prerequisite: *Zoology 1-2*.

B. Graduate Courses

Zoology 101-102—General Zoology. C, 2 hours; L, 6 hours. 5 points each session. Professor MCGREGOR (Columbia College); Professors CRAMPTON and L. H. GREGORY (Barnard College).

This course covers the same general ground as *Zoology 91-92*, but is supplemented by additional assigned work.

Zoology 103—Comparative Embryology of Vertebrates. C, 1 hour; L, 2-5 hours. 3 points. Professor MCGREGOR.

Covers the same ground as *Zoology 93*, with additional assigned work.

Zoology 110—The Parasitic Protozoa. C, 1 hour; L, 4 hours. 3 points. Professor CALKINS.

A systematic treatment of the protozoan parasites, with special reference to the human pathogenic forms. Open to undergraduates who have had *Zoology 91* or its equivalent.

Zoology 151-152—General Physiology. General principles of human and animal physiology. C, 2 hours; L, 4 hours. 4 points each session. Professor L. H. GREGORY (Barnard College). Open to women only.

*C. Advanced Graduate Courses**General Zoology*

The two following courses are designed to complete the work in general zoology begun in *Zoology 1-2* and continued in *Zoology 91-92*. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification. Lectures, seminar, and laboratory work.

Zoology 201—Topics in Invertebrate Zoology, with Especial Reference to Problems of Phylogeny. C, 2 hours; L, 8-10 hours. 8 points. Professor WILSON.

Zoology 223-224—Evolution of the Vertebrates. I (223), Fishes Recent and Fossil. II. (224), Amphibia and Reptiles; Origin of the Birds; Origin of the Mammals. Systematic, phylogenetic, and morphological studies. Evolution of the head and locomotive apparatus of vertebrates. C, 2 hours; L, 3 hours. 4 points each session. Given at the American Museum. Professor W. K. GREGORY.

The material studied comprises over 700 specimens of recent and fossil types.

Zoology 225-226—Cellular Biology. General structure and functions of the cell with especial reference to development and heredity, cytology and cellular embryology. C, 2 hours; L, 6 hours. 3 or 6 points each session. Professor WILSON.

Morphology and Evolution of Special Groups

Zoology 203-204—Mammals, Living and Fossil. C, 1 hour; L, 5-10 hours. 4 points each session. Professor W. K. GREGORY.

Structure, origin, and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum.

Protozoology

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life histories, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Parasitic Protozoa (see page 22).

Zoology 221-222—Protozoology. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology, and physiology. C, 1 hour; L, 8 hours. 5 points each session. Professor CALKINS.

Zoology 230—Experimental Protozoology. C, 1 hour; L, 4 hours. 4 points. Professor CALKINS.

The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization, and age. Individual research problems for registered students.

Prerequisite: 221.

Experimental Zoology

The following courses (215-218 with 213-214) cover three year's work. Each course may be taken independently of the others and not necessarily in the order given.

Zoology 213—Tropisms. (To be given 1920.) C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

This course deals with the simpler responses of organisms to external agents and serves as an introduction to the next course, *Zoology 214*.

Prerequisite: *Zoology 1-2, 91-92*.

Zoology 214—Instincts. (To be given 1921.) An analysis of the more complex behavior of animals and the problems of the evolution of instinct and intelligence. C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

Prerequisite: *Zoology 1-2, 91-92*.

Zoology 215-216—Genetics. C, 2 hours; L, 6 hours. 6 points each session. Laboratory work on special problems. Professor MORGAN.

Approximately two-thirds of the year is given to Mendelian heredity and genetics; the remainder to the influence of environment in modifying organisms and in affecting their modes of reproduction (sex determination).

Zoology 217—Physiological Morphology. (To be given 1919.) C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

A discussion of theories dealing with the relation of function and structure as illustrated by growth, regeneration, transplantation, and tissue culture.

Zoology 218—Experimental Embryology. (To be given 1920.) The rôle of external factors in development. C, 1 hour; L, 5 hours. 4 points. Professor MORGAN.

Special Research

Zoology 227-228—Investigation of special problems in any of the subjects enumerated above. Variable. Not in general counted as part of course-work.

Courses in Summer Session and Extension Teaching: Columbia

Zoology s1—Elemental Biology and Zoology. Lectures and laboratory work. Credit I. 4 points. Professor MCGREGOR.

Prerequisite: *Natural Science A*, or *Elementary Chemistry*, or *Physics*.

NOTE: This course is not the exact equivalent of *Zoology 1*. Although elementary, it is not sufficiently simple to be adapted to the needs of high school pupils.

In the requirements for the Medical School the above courses will supplement *Botany s2-s2a*. The class will be limited to forty students.

Zoology s121—Protozoology. Lectures, demonstrations, and laboratory work amounting to not less than twenty-four hours per week. Credit IA, II. 5 points. Professor CALKINS.

Courses in Extension Teaching: Long Island College Hospital

Zoology e1-2—Elementary Biology and Zoology. Lectures and laboratory. 4 points each session. Professor CALKINS, Messrs. PERKINS, STRONG, and AGERS-BORG.

Zoology e3—General Embryology. 3 points. Mr. PERKINS. Given in Winter Session of 1920, alternating with *e7*.

Zoology e4—Advanced Biology. 3 points. Professor CALKINS. Given in Spring Session, 1920, alternating with *e8*.

Zoology e5-6—Vertebrate Comparative Morphology. 3 points each session. Mr. PERKINS.

Zoology e7—Histological Technique. 3 points. Mr. ELWYN.
Given in Winter Session, 1919, alternating with e3.

Zoology e8—Human Parasitology. 3 points. Professor CALKINS.
Given in Spring Session, 1919, alternating with e4.

Courses in Biometrical Methods

Anthropology 121—Anthropometry—Biometrical Methods. C, 2 hours. 3 points. Professor BOAS.

This course treats of the methods of measuring variable quantities, such as those with which biology has to deal. After an exposition of the elementary principles of measurement, the interrelations of measurements are discussed as well as the methods of studying variable quantities that are subject to change. For those desiring to prepare for research work in biometry, special hours of practical exercises will be arranged.

Anthropology 122—Anthropometry—Growth. C, 2 hours. 3 points. Professor BOAS.

A discussion of the phenomena of growth with special relation to the influences of heredity and of environment.

Courses under the George Crocker Special Research Fund

Zoology 202—General Biology of Tumors. 4 points. Professor WOGLOM.
Prerequisite: *Mammalian histology.*

Zoology 205-206—Research in Problems of Growth Pathology with Especial Reference to Tumors. Credit to be assigned in individual cases at the time of registration. 4-12 points each session. Professors WOOD and WOGLOM and Drs. PRIME and BULLOCK.

The laboratories of the George Crocker Special Research Fund are open to properly qualified workers for research in pathology under the supervision of the Director of Cancer Research.

Zoology 209—Morphology and Classification of Tumors, including Pathological Technique. 4 points. Professor WOOD.

Prerequisite: *Mammalian histology.*

Course in the College of Pharmacy

A laboratory course of 200 hours in the general biology of plants and animals is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy.*

Course in the College of Physicians and Surgeons

Zoology 101—Histology and Embryology. 12 hours. 8 points.

Courses in Teachers College

Courses dealing with the teaching of biology and nature-study, open to seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in the Department of Biology of Teachers College by Professors BIGELOW and BROADHURST and Miss STACKPOLE. See Biology and Nature-Study in the current *Announcement of Teachers College, School of Education.*

ACADEMIC CALENDAR

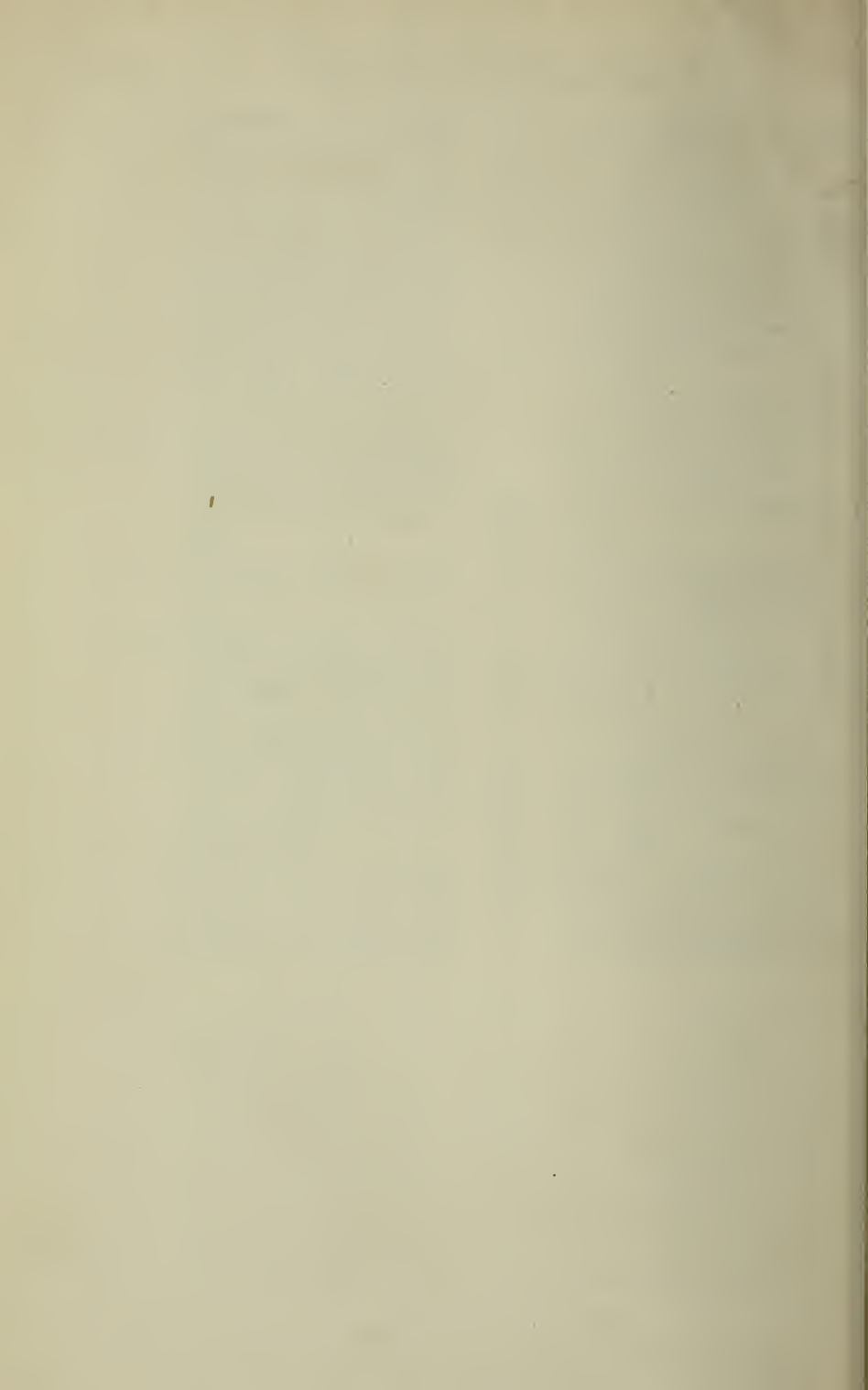
1919-1920

1919

- July 7, Monday. Twentieth **Summer Session begins.**
- Aug. 1, Friday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October. The privilege of later application may be granted up to August 15 on payment of a fee of \$5. Last day for filing applications for deficiency and special examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Aug. 15, Friday. Twentieth **Summer Session ends.**
- Sept. 8, Monday. Last day for filing applications for entrance examinations, and for advanced standing. The privilege of later application may be granted on payment of a fee of \$5.
- Sept. 15, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.
- Sept. 17, Wednesday. **Registration** (including the payment of fees) **begins.**
- Sept. 23, Tuesday. Registration ceases for students previously matriculated except graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$5.
- Sept. 24, Wednesday. **Winter Session, 166th year, begins.** Registration ceases for students not previously matriculated, except graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$5.
- Sept. 27, Saturday. Registration ceases for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts. The privilege of later application may be granted up to October 19 on payment of a fee of \$5.
- Oct. 1, Wednesday. Last day for filing essay for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October. Last day for filing applications for all degrees to be conferred in October, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Oct. 4, Saturday. Last day for making changes in program, except for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts.

- Oct. 18, Saturday. Last day for re-receiving late applications for registration and for making changes in program for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts.
- Oct. 21, Tuesday. Stated meeting of University Council.
- Nov. 4, Tuesday. Election Day, holiday.
- Nov. 26, Wednesday. **Annual Thanksgiving Service** in St. Paul's Chapel.
- Nov. 27, Thursday, to November 29, Saturday, inclusive. Thanksgiving holidays.
- Dec. 1, Monday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in February. The privilege of later application may be granted up to December 15 on payment of a fee of \$5.
- Dec. 7, Sunday. **Annual Commemoration Service** in St. Paul's Chapel.
- Dec. 16, Tuesday. Stated meeting of University Council.
- Dec. 22, Monday, to
- 1920**
- Jan. 3, Saturday, inclusive. Christmas holidays.
- Jan. 8, Thursday. Last day for filing applications for entrance examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Jan. 15, Thursday. Mid-year entrance examinations begin.
- Jan. 21, Wednesday. Mid-year examinations begin.
- Jan. 31, Saturday. **Registration** (including the payment of fees) **begins.**
- Feb. 2, Monday. Last day for filing applications for all degrees to be conferred in February, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Feb. 3, Tuesday. **Winter Session ends.** Last day for filing essay for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in February. Registration ceases for students entering Spring Session. The privilege of later registration may be granted up to March 1 for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts on payment of a fee of \$5.
- Feb. 4, Wednesday. **Spring Session begins.** **University Service** in St. Paul's Chapel.
- Feb. 12, Thursday. Alumni Day.
- Feb. 14, Saturday. Last day for making changes in program, except for graduate students in Political Science, Philosophy, Pure Science, Education, and Practical Arts.
- Feb. 17, Tuesday. Stated meeting of University Council.
- Feb. 23, Monday. Washington's Birthday, holiday.
- Feb. 28, Saturday. Last day for receiving late applications for registration and for making changes in program for graduate students in Political Science,

- Philosophy, Pure Science, Education, and Practical Arts.
- Mar. 1, Monday. Last day for filing applications for University Fellowships and Scholarships. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in June. The privilege of later application may be granted up to March 15 on payment of a fee of \$5.
- Apr. 1, Thursday. Last day for filing applications for examination for the degree of Doctor of Philosophy to be conferred in June.
- Apr. 1, Thursday, to April 5, Monday, inclusive. Easter holidays.
- Apr. 15, Thursday. Last day for filing applications for all degrees to be conferred in June, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$5.
- Apr. 19, Monday. Last day for filing applications for deficiency and special examinations. The privilege of later application may be granted on payment of a fee of \$5.
- Apr. 20, Tuesday. Stated meeting of University Council.
- May 1, Saturday. Last day for students in Columbia College to file choice of studies for following year. The privilege of filing such choice later may be granted on payment of a fee of \$5.
- Last day for filing applications for scholarships in the Schools of Law, Applied Science, and Architecture.
- May 17, Monday. Final examinations begin.
- May 19, Wednesday. Last day for filing essays for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in June.
- May 30, Sunday. **Baccalaureate Service.**
- May 31, Monday. Class Day, Memorial Day, holiday.
- June 2, Wednesday. **Commencement Day.**
- June 9, Wednesday. **Spring Session ends.**
- June 21, Monday. Entrance examinations begin.
- July 6, Tuesday. Twenty-first **Summer Session begins.**



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1922/23

Twenty-second Series, No. 32



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Columbia University Bulletin of Information

DIVISION OF BIOLOGY

COURSES IN ANATOMY, BACTERIOLOGY, BIOLOGICAL
CHEMISTRY, BOTANY, PATHOLOGY,
PHYSIOLOGY, ZOOLOGY

ANNOUNCEMENT

1922-1923

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Twenty-second Series, No. 32

July 22, 1922

Issued at Columbia University, Morningside Heights, New York, N. Y., thirty-seven times during the academic year, weekly between December and August. Entered as second-class matter August 10, 1918, at the post-office at New York, N. Y., under the Act of August 24, 1912. Acceptance for mailing at a special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized. These include:

1. Annual Reports of the President and Treasurer to the Trustees.
2. The Catalogue of the University, price twenty-five cents, and the Announcements of the several Colleges and Schools, and of certain Divisions, issued in the Spring, and relating to the work of the next year. These are made as accurate as possible, but the right is reserved to make changes in detail as circumstances require. The current number of any of these Announcements will be sent without charge upon application to the Secretary of the University.

C.N.P.-2000-1922

THE DIVISION OF BIOLOGY

OFFICERS

- NICHOLAS MURRAY BUTLER *President of the University*
LL.D. (Cantab.), D. Litt. (Oxon.), Hon. D. (Paris).
- GEORGE S. HUNTINGTON *Professor of Anatomy, Executive Officer,*
Department of Anatomy
A.B., Trinity, 1881; A.M., 1884; M.D., Columbia, 1884; Sc.D., 1904; LL.D., Jefferson Medical College, 1907.
- HENRY FAIRFIELD OSBORN *Research Professor of Zoology*
A.B., Princeton, 1877; Sc.D., 1880; LL.D., Trinity (Hartford), 1901; Princeton, 1902; Columbia, 1907; Sc.D., Cambridge, 1904; Ph.D. (Hon.) Christiania, 1911; Member of National Academy of Sciences.
- EDMUND B. WILSON *Da Costa Professor of Zoology, Executive Officer,*
Department of Zoology
Ph.B., Yale, 1878; LL.D., 1901; Ph.D., Johns Hopkins, 1881; LL.D., 1902; LL.D., Chicago, 1901; Sc.D., Cambridge, 1909; M.D. (Hon.), Leipsic, 1909; Member of National Academy of Sciences.
- FREDERIC S. LEE *Research Professor of Physiology*
A.B., St. Lawrence, 1878; A.M., 1881; LL.D., 1918; Ph.D., Johns Hopkins, 1885.
- BASHFORD DEAN *Professor of Vertebrate Zoology*
A.B., College of the City of New York, 1886; A.M., Columbia, 1889; Ph.D., 1890; Chevalier de la Légion d'Honneur, 1910.
- HENRY E. CRAMPTON *Professor of Zoology*
A.B., Columbia, 1893; Ph.D., 1899.
- WILLIAM J. GIES *Professor of Biological Chemistry, Executive Officer,*
Department of Biological Chemistry
B.S., Pennsylvania College, 1893; M.S., 1896; Sc.D., 1914; Ph.B., Yale, 1894; Ph.D., 1897.
- HERBERT MAULE RICHARDS *Professor of Botany*
B.S., Harvard, 1891; Sc.D., 1895.
- GARY N. CALKINS *Professor of Protozoology*
B.S., Massachusetts Institute of Technology, 1890; Ph.D., Columbia, 1898; Member of National Academy of Sciences.
- MAURICE A. BIGELOW *Professor of Biology and Director of the School of*
Practical Arts in Teachers College
B.S., Ohio Wesleyan, 1894; M.S., Northwestern, 1896; Ph.D., Harvard, 1901.
- FRANCIS CARTER WOOD *Director of the Institute of Cancer Research*
B.S., Ohio State, 1891; M.D., Columbia, 1894. Pathologist and Attending Physician to St. Luke's Hospital; Consulting Pathologist, Lincoln Hospital and Vassar Brothers' Hospital, Poughkeepsie.
- RUSSELL BURTON-OPITZ *Associate Professor of Physiology*
M.D., Chicago, 1895; B.S., 1898; M.S., 1902; Ph.D., 1905.
- THOMAS HUNT MORGAN *Professor of Experimental Zoology*
B.S., State College of Kentucky, 1886; Ph.D., Johns Hopkins, 1891; LL.D., 1915; Member of National Academy of Sciences.

- BERN B. GALLAUDET *Assistant Professor of Anatomy*
A.B., Trinity, 1880; A.M., 1883; M.D., Columbia, 1884.
- JOHN HENRY LARKIN *Assistant Professor of Pathology*
A.B., Manhattan, 1891; M.D., Columbia, 1894.
- JAMES HOWARD MCGREGOR *Associate Professor of Zoology*
B.S., Ohio State, 1894; A.M., Columbia, 1896; Ph.D., 1899.
- CARLTON CLARENCE CURTIS *Associate Professor of Botany*
A.B., Syracuse, 1889; Ph.D., 1897; A.M., Columbia, 1895.
- TRACY E. HAZEN *Assistant Professor of Botany*
A.B., Vermont, 1897; A.M., Columbia, 1899; Ph.D., 1900.
- ROBERT A. HARPER *Torrey Professor of Botany, Executive Officer,
Department of Botany*
A.B., Oberlin, 1886; A.M., 1891; Ph.D., Bonn, 1896; Member of National Academy of Sciences.
- FRANK HENRY PIKE *Associate Professor of Physiology,
Executive Officer, Department of Physiology*
A.B., Indiana, 1903; Ph.D., Chicago, 1907.
- WILLIAM HENRY WOGLOM *Associate Professor of Cancer Research*
M.D., Columbia, 1901, B.S., 1921.
- HANS ZINSSER *Professor of Bacteriology, Executive Officer,
Department of Bacteriology*
A.B., Columbia, 1899; A.M. and M.D., 1903.
- ALWIN M. PAPPENHEIMER *Associate Professor of Pathology*
A.B., Harvard, 1898; M.D., Columbia, 1902.
- FREDERICK TILNEY *Professor of Neurology and Neuro-Anatomy*
A.B., Yale, 1897; M.D., Long Island College Hospital, 1903; Ph.D., Columbia, 1912.
- JEAN BROADHURST *Assistant Professor of Biology in Teachers College*
B.S., Columbia, 1903; A.M., 1908; Ph.D., Cornell, 1914.
- HORATIO B. WILLIAMS *Assistant Professor of Physiology*
A.B., Syracuse, 1900; M.D., 1905.
- WILLIAM K. GREGORY *Associate Professor of Vertebrate Palæontology*
A.B., Columbia, 1900; A.M., 1905; Ph.D., 1910.
- OLIVER SMITH STRONG *Associate Professor of Neurology
and Instructor in Anatomy*
A.B., Princeton, 1886; A.M., Columbia, 1892; Ph.D., 1896.
- LOUISE HOYT GREGORY *Assistant Professor of Zoology in Barnard College*
A.B., Vassar, 1903; A.M., Columbia, 1907; Ph.D., 1909.
- VERA DANCHAKOFF *Assistant Professor of Anatomy*
M.D., Lausanne, 1902; M.D., Charkow, 1903; Petrograd Academy of Medicine, 1907.
- JAMES W. JOBLING *Professor of Pathology*
M.D., Tennessee Medical College, 1897.
- ERNEST L. SCOTT *Assistant Professor of Physiology*
S.B., Ohio Wesleyan, 1902; S.M., Chicago, 1911; Ph.D., Columbia, 1914.
- ADOLPH ELWYN *Assistant Professor of Anatomy*
B.S., Columbia, 1915; A.M., 1917.
- J. HOWARD MUELLER *Assistant Professor of Bacteriology*
B.S., Illinois Wesleyan, 1912; M.S., University of Louisville, 1914; Ph.D., Columbia, 1916.

- FREDERICK PRIME, JR. *Assistant Professor of Cancer Research*
B.S., University of Pennsylvania, 1902; M.D., 1905.
- EDGAR G. MILLER, JR. *Assistant Professor of Biological Chemistry*
B.S., Gettysburg, 1911; Ph.D., Columbia, 1913.
- WILLIAM CLINTON JOHNSON *Assistant Professor of Pathology*
A.B., Williams, 1905; M.D., Columbia, 1909.
- FREDERICK D. BULLOCK *Associate in Cancer Research*
B.S., Kentucky State College, 1899; M.D., Johns Hopkins, 1907.
- JAMES G. DWYER *Associate in Bacteriology*
A.M., Queen's 1902; M.D., 1905; Ph.D., Columbia, 1918.
- J. GARDNER HOPKINS *Associate in Roentgenology and Bacteriology*
A.B., Columbia, 1902; M.D., Johns Hopkins, 1907.
- FREDERIC PARKER, JR. *Associate in Bacteriology*
A.B., Harvard, 1913; M.D., 1916.
- WILLIAM CARSON VON GLAHN *Associate in Pathology*
B.S., Davidson College, 1911; M.D., Johns Hopkins, 1915.
- THEODORE FREDERICK ZUCKER *Associate in Pathology*
M.S., University of Illinois, 1912; A.B., Concordia College, 1907.
- WILLIAM F. BENDER *Instructor in Physiology*
M.D., Columbia, 1913.
- ROBERT HALL BOWEN *Instructor in Zoology*
A.B., Colby, 1914; A.M., Columbia, 1916; Ph.D., 1920.
- HELEN C. COOMBS *Instructor in Physiology*
A.B., Columbia, 1911; B.S., 1914; A.M., 1915; Ph.D., 1918.
- MARY W. COUTANT (Mrs.) *Instructor in Botany*
A.B., Columbia, 1913; A.M., 1915.
- ALFRED FEINBERG *Instructor in Medical Illustrating*
- ANN GAYLOR KUTTNER *Instructor in Bacteriology*
B.S., Columbia, 1915; A.M., 1920.
- FLORENCE DE L. LOWTHER *Instructor in Zoology in Barnard College*
A.B., Columbia, 1912; A.M., 1915.
- CAROLINE E. STACKPOLE *Instructor in Biology in Teachers College*
B.S., Columbia, 1906; A.M., 1907.
- WALKER E. SWIFT. *Instructor in Physiology*
A.B., Yale, 1915; M.D., Columbia, 1919.
- MARION E. RICHARDS (Mrs.) *Lecturer in Botany in Barnard College*
A.B., Columbia, 1903; A.M., 1905.
- M. GRACE SPRINGER *Lecturer in Zoology*
A.B., Oberlin, 1920; A.M., 1921.
- RHODA WILLIAMS BENHAM *Assistant in Botany*
A.B., Columbia, 1917; A.M., 1919.
- PHILIP COHN *Assistant in Botany*
B.S., Cornell, 1918.
- LULU O. GAISER *Assistant in Botany*
A.B., Western University (London, Ont.), 1916; A.M., Columbia, 1921.
- ALEXANDER GERSHOY *Assistant in Botany*
B.S., Cornell, 1918.

- H. HERBERT JOHNSON, JR. *Assistant in Zoology*
 B.S., Mercer, 1918; A.M., Columbia, 1920.
- FRANCES KRASNOW *Assistant in Biological Chemistry*
 B.S., Columbia, 1917; A.M., 1917.
- HERBERT S. WARREN *Assistant in Zoology*
 B.S., College of City of New York, 1911; A.M., Columbia, 1920.

MEMBERS OF THE STAFF OF THE NEW YORK BOTANICAL GARDEN GIVING
 INSTRUCTION IN THE DIVISION

- NATHANIEL LORD BRITTON, Ph.D., Sc.D., LL.D. *Director*
- HENRY ALLAN GLEASON, Ph.D. *Assistant Director*
- WILLIAM ALPHONSO MURRILL, Ph.D. *Supervisor of Public Instruction*
- ARLOW BURDETTE STOUT, Ph.D. *Director of Laboratories*
- JOHN KUNKEL SMALL, Ph.D. *Head Curator the Museums*
- FRED. JAY SEAVER, Ph.D. *Curator*
- PER AXEL RYBERG, Ph.D. *Curator*
- MARSHALL AVERY HOWE, Ph.D. *Curator*
- ARTHUR HOLLICK, Ph.D. *Paleobotanist*
- HENRY HURD RUSBY, M.D. *Curator of Economic Collections*
- WILLIAM J. GIES, Ph.D. *Consulting Chemist*
- ELIZABETH G. BRITTON *Honorary Curator*

UNIVERSITY OFFICERS OF ADMINISTRATION

- WILLIAM H. CARPENTER, Ph.D. *Provost of the University*
- FRANK DIEHL FACKENTHAL, A.B. *Secretary of the University*
- ADAM LEROY JONES, Ph.D. *Director of University Admissions*
- EDWARD J. GRANT, A.B. *Registrar of the University*
- CHARLES S. DANIELSON *Bursar of the University*
- HENRY L. NORRIS, M.E. *Superintendent of Buildings and Grounds*
- REV. RAYMOND C. KNOX, S.T.D. *Chaplain of the University*
- GEORGE L. MEYLAN, M.D. *Medical Director of the Gymnasium*
- WILLIAM H. MCCASTLINE, M.D. *University Medical Officer*

GENERAL STATEMENT

The Division of Biology includes the following departments, Anatomy, Bacteriology, Biological Chemistry, Botany, Pathology, Physiology, and Zoology, which offer courses of study leading to university degrees. This bulletin is designed primarily for advanced students and for candidates for the degrees of Masters of Arts and Doctor of Philosophy. Other students should consult the *Announcements* of Columbia College, Barnard College, University Extension, Summer Session, College of Physicians and Surgeons, School of Education and School of Practical Arts, which may be had from the Secretary of the University.

The university requirements for the degrees of Master of Arts and Doctor of Philosophy are stated in full in the *Announcement of the Faculties of Political Science, Philosophy and Pure Science*, which will be sent upon application to the Secretary of the University. This *Announcement* contains also full information with regard to fellowships, scholarships, prizes, student employment, appointments, university and tuition fees, and all other university matters of interest to advanced students. Special departmental requirements for the degrees of Master of Arts and Doctor of Philosophy are stated under the separate departmental headings.

The interest of the Dyckman Fund, amounting to \$400 annually, may be awarded in the form of grants for the encouragement of biological research.

ORGANIZATION AND EQUIPMENT

Anatomy. The laboratory for advanced morphological research occupies the third story of the Anatomical Building of the College of Physicians and Surgeons (Tenth Avenue and Fifty-ninth Street). Every facility for work in morphology is here extended. The established connections of the department furnish abundant human and comparative material, both mature and embryonic. The private library of the Professor of Anatomy is at the disposal of advanced workers.

Bacteriology. The Department of Bacteriology occupies the western section of the fifth floor of the north building of the College of Physicians and Surgeons. It comprises a laboratory for the accommodation of the undergraduate and advanced classes in bacteriology, a research laboratory for special advanced workers, and rooms equipped for the preparation of culture media. The laboratories are well supplied with all necessary apparatus for the culture and study of micro-organisms and with cold-storage facilities. A large collection of identified bacterial species is kept under cultivation.

A Journal Club meets at different times during the year, usually about once in two weeks, in which the staff and suitably prepared graduate students participate.

Biological Chemistry (Nutrition). At the College of Physicians and Surgeons the Department of Biological Chemistry occupies eight rooms well equipped for experimental work. Two of these are relatively large and will accommodate

about seventy workers at a time. Five smaller rooms are specially fitted up for investigations by advanced students. Professor Gies' library occupies a room adjoining the laboratory and is accessible by appointment to all workers in the department. At Teachers College there is a well-equipped laboratory for practical instruction and research in biological chemistry. Special facilities have also been provided at the New York Zoological Park for research under the direction of the head of the department. The chemical laboratory in the Department of Pathology at Bellevue Hospital and the laboratories of the New York Botanical Garden, where the Professor of Biological Chemistry is consulting chemist, are open to students.

Botany. The Department of Botany occupies the third floor of Schermerhorn Hall, and the laboratories and lecture-rooms are equipped with apparatus and material for morphological and physiological work.

Similar opportunities are offered to women in the laboratories at Barnard College.

A greenhouse connected with a small laboratory and dark room and equipped with a considerable amount of physiological apparatus, affords facilities for experimental work in physiology and pathology, and provides living material under favorable conditions for all instructional courses. A culture room with modern equipment for growing fungi and algæ in pure cultures is also available.

A seminar for the study of special subjects in general physiology meets weekly, and a botanical conference meets monthly where members of the staff and students present the results of their own work or review the progress of botanical research elsewhere. For the study of the current literature there is also a biweekly colloquium.

Under agreement with the University, the Botanical Garden supplies facilities for research for members of the staff and for properly accredited students. This combination of forces places the Department of Botany within reach of material, equipment, and collections not otherwise available, and opens up facilities for research work under exceptionally favorable conditions. The Museum of the New York Botanical Garden is located in Bronx Park, and its entire upper floor is devoted to research. The physiological and morphological laboratories occupy the western end, and the taxonomic laboratories and herbarium the eastern end. Among the special features provided are to be mentioned the dark rooms, photographic, operating, and balance room, and laboratory for physiological chemistry. The Columbia herbarium and the collections of the New York Botanical Garden are housed in the large room in the east wing of the Museum. The cryptogamic collections are in special rooms. Ample opportunity for experimental work in plant breeding and in plant pathology is afforded by the open-air plantations and horticultural houses. The library comprises over 20,000 volumes in addition to sets of the important botanical journals.

Pathology. The Department of Pathology occupies the greater part of the fourth floor of the north building of the College of Physicians and Surgeons, together with class laboratories, on the fifth floor. On the fourth floor, there are, besides the rooms devoted to the staff, rooms with abundant desk room for special workers, an operating room for aseptic experimental work, chemical laboratory,

the museum, preparation rooms, cold storage, etc. The rooms on this floor are occupied by the library, which is accessible to workers in this and related departments. The museum of pathology is used for the instruction of medical students and as a place of deposit of specimens showing rare forms of lesion. On the roof there is accommodation for animals, together with special rooms for experimental work. The entire space is amply lighted, and equipped with apparatus necessary for routine teaching and special research.

The pathological laboratories of the Presbyterian Hospital are also available for special work under control of the director.

Physiology. The main equipment of the Department of Physiology is at the College of Physicians and Surgeons. It comprises two laboratories equipped primarily for teaching; seven laboratories for research; several private rooms for the use of the officers of the department; the Swift Physiological Cabinet, containing a collection of apparatus of precision, for teaching and research; a library containing sets of the physiological journals, monographs, other books and reprints; two dark rooms for optical and photographic work; and an outfit of machines and tools for working in wood and metal. A skilled mechanic gives his entire time to the design, manufacture, and repair of apparatus. The laboratories are connected by wires with the Vanderbilt Clinic and the Roosevelt Hospital, so that the string galvanometers of the department are available for making electrocardiographic records from patients. In Schermerhorn Hall at Morningside Heights the Department has the use of a laboratory equipped for the instruction of undergraduates.

Zoology. The zoological laboratories on the upper floor of Schermerhorn Hall comprise a general undergraduate laboratory, two graduate laboratories, a laboratory for experimental zoology, and eight rooms for private research, besides rooms for supplies, aquaria, and preparation. There is also a lecture-room and a library and seminar room.

Owing to the accessibility of the collections of the American Museum of Natural History, the department does not maintain a general zoological museum. The equipment includes, however, a teaching collection of animals, anatomical preparations, charts and wax models.

The laboratories of Barnard College are equipped for the work of the women students in undergraduate courses of instruction.

The departmental library, the gift of Charles H. Senff, Esq., is a memorial to the late Dr. John I. Northrop. It embraces sets of the standard biological works, and includes journals and special monographs. A fund is available for the purchase of literature needed in connection with the special researches of students. The libraries of the New York Academy of Sciences and of the New York Academy of Medicine are also available for consultation.

The American Museum of Natural History contains extensive collections illustrating the zoology and palæontology of invertebrates and vertebrates, both from the systematic and bionomic points of view. The exhibition halls are always open to students, and certain of the University lectures and courses of research are conducted in the Museum.

The Zoological Park in the Borough of the Bronx, under the direction of the New York Zoological Society, affords exceptional opportunities for the study of living reptiles, birds, and mammals.

The New York Aquarium, also under the management of the Zoological Society, offers facilities for advanced research students in a special laboratory. The collections include fresh-water vertebrates and invertebrates and a fish hatchery, which is in operation all the year round.

The Journal Club, which is open to instructors and all advanced students, meets regularly in the department library to report upon special investigations and to present abstracts of articles of special importance in the biological journals.

The Marine Biological Laboratories at Woods Hole, Massachusetts, and at Cold Spring Harbor, Long Island, form a valuable adjunct to the biological instruction of the University. In the former, five investigators' rooms (ten tables) are subscribed for by the University for the use of the Department of Zoology; in the latter, a table is available through the John D. Jones Scholarship.

COURSES OF INSTRUCTION

ANATOMY¹

Anatomy 101-102—Histology and embryology. Lectures, conferences, and laboratory work. 8 hours. Graduate work in Anatomy for one year. Hours and credit to be determined on consultation. Professors ELWYN, STRONG, DANCHAKOFF, and staff.

Anatomy 103-104—Anatomy of the extremities, preliminary visceral anatomy. Demonstrations, recitations, conferences, and dissections. 12 hours. Credit, eligibility and hours to be determined on consultation. Professor GALLAUDET, Dr. VAUGHAN and staff.

Anatomy 105-106—Anatomy of head, abdomen, and thorax. Demonstration, conferences, laboratory work, and dissections. 12 hours. Credit, eligibility and hours to be determined on consultation. Professor GALLAUDET, Dr. VAUGHAN and staff.

Anatomy 107-108—Vertebrate morphology. Organogeny. Lectures combined with demonstrations. The course takes up the adult structure of the body cavities and viscera from the genetic standpoint, and includes the consideration of the general topics of evolution, heredity, and variation in their relation to the study of medicine. 2 hours; Winter and Spring Sessions, first year, and Winter Session, second year. Credit, eligibility and hours to be determined on consultation. Professor HUNTINGTON.

Summer Session

Anatomy s101—Histology. General histology, histogenesis, microscopical anatomy, and organogenesis. Conferences and laboratory exercises. 15 hours. 6 points. Professor ELWYN.

University Extension

Neurology e223-224—Neuro-anatomy. The anatomy, histology, development and architectonics of the nervous system of man. Lectures, demonstrations, conferences, and laboratory work. 3 points each Session. Professors TILNEY and ELWYN.

F. at 7:10 p. m. Given at P. and S.

BACTERIOLOGY

Candidates for the degrees of Master of Arts and Doctor of Philosophy taking these courses are required to have a working knowledge of the microscope, and a general acquaintance with elementary biology and practical chemistry. They should fulfil the requirements exacted of candidates for entrance to the medical school. No preliminary work in bacteriology is required. There are no courses in this department providing the necessary preliminary training; but this may

¹ For courses in Neurology see the *Announcement of the College of Physicians and Surgeons*.

be secured in the Department of Chemistry, in the Department of Zoology, in the Department of Botany, or in the Department of Biology of Teachers College.

For the degree of Master of Arts the student must include among the courses he elects Courses 105, 201 and 208. An essay based on work of a research nature or a critical review is also required.

For admission to candidacy for the Ph.D. degree, the student must be able to read French and German, must have done the work in Courses 105, 201, and 208, and must be recommended by the department as able to undertake research.

Bacteriology 101—General bacteriology, especially adapted to the requirements of students of medicine and graduate work in Bacteriology for one half year. Lectures, demonstrations and laboratory work. Given in the Department of Bacteriology under the Medical Faculty. 13 hours, 12 weeks, credit to be determined. Winter Session. Professors ZINSSER and MUELLER, Drs. DWYER, PARKER, and Miss KUTTNER.

Bacteriology 105—The principles of infection, immunity, serum diagnosis, and therapy. Advanced bacteriology. Eligibility, hours, and credit to be determined on consultation. Lectures with demonstrations. 2 hours. Winter Session. Professor ZINSSER.

Text-book: Zinsser's *Infection and Resistance*.

Bacteriology 201—Advanced bacteriology. The application of bacteriology to epidemiological problems. The course is given but once during the year, and requires attendance at the laboratory during the entire afternoon, in October, November, December and January. 18 hours. Credit, eligibility and hours to be determined on consultation. Winter Session. Dr. PARKER and Miss KUTTNER.

Prerequisite: Bacteriology 101.

This course offers an opportunity for a limited number of graduates in medicine, or other qualified workers, to receive instruction in general and applied bacteriology (the application of bacteriological methods to the solution, not only of medical, but also of sanitary, hygienic, and various industrial problems being held in view).

The course embraces methods of preparation, staining, microscopic study; preparation of culture media; study and record of observation of selected typical species; methods of isolation of species; systematic analysis for the determination of cultural characters, biochemical reactions, and identifications of species; cultural study of all important pathogenic bacteria; methods of determining pathogenicity and immunity reactions; modes of testing the value of disinfectants, and of germicides.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle, u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*, Mace's *Bacteriologie*.

Bacteriology 203-204—Special bacteriology. Rating individually determined for each student at the time of registration. 6 to 18 hours laboratory. 3-9 points each Session. Professor ZINSSER, Drs. MUELLER and PARKER.

Continuation of Course 201, with additional study of known species of bacteria; special study of the chemical products formed in the growth of bacteria; and the pursuit of some selected theme for original investigation.

Text-books: Hiss and Zinsser's *Text-book of Bacteriology*, Kolle u. Wassermann's *Handbuch der Pathogenen Mikroorganismen*.

Bacteriology 205—Public health lectures. The coordination of Bacteriology and Immunity with Public Health problems. 1 hour. 1 point. Winter Session. Professor ZINSSER.

Bacteriology 208—A practical laboratory course in the technique of serum study. Credit, eligibility and hours to be determined on consultation. 6 hours, Spring Session; limited to twenty students. Professor ZINSSER, Drs. PARKER and HOPKINS.

Prerequisites: 105 and 201.

Bacteriology 209 or 210—Clinical bacteriology. Rating individually determined at time of registration. Winter or Spring Session. Dr. DWYER.

A course will be given at the laboratory of the Manhattan Eye, Ear, and Throat Hospital in which a small group of students will be taught the methods of examining material from patients suffering from infections chiefly of the eye, ear, nose, and throat. The course will include the bacteriological diagnosis of material, the making of blood cultures, the making of autogenous vaccines and their use in the treatment of patients, etc.

Bacteriology 211 or 212—Clinical serology. 2 points either Session. Dr. HOPKINS and assistants.

Technique of Wassermann reaction and other clinical serum reactions. Laboratory open to properly qualified graduate students, to physicians and to undergraduates who have taken courses 203-204 and 208 or equivalent.

Bacteriology 251-252—Research in bacteriology. 2 to 8 points each Session. Under the direction of the Professor of Bacteriology.

Rating individually determined at the time of registration.

Summer Session

Bacteriology s101—General bacteriology. 5 to 6 points, equivalent to Course 101. Dr. DWYER.

Barnard College

Botany 151-152—Bacteria and ferment fungi.

Teachers College

For courses in bacteriology applied to practical arts given in Teachers College by Professor BROADHURST, see the separately printed *Announcement of Teachers College, School of Practical Arts*.

College of Pharmacy

For details of a laboratory course of thirty-two hours in Bacteriology, given in the College of Pharmacy, see the separately printed *Announcement of the College of Pharmacy*.

BIOLOGICAL CHEMISTRY

(Nutrition)

A prerequisite for graduate work in biological chemistry is the possession of knowledge of physics, chemistry and biology sufficient to meet the requirements for admission, in this university, to the study of medicine. (See *Announcement of the School of Medicine*.)

The departmental requirements for the higher degrees are the following:
For the A.M. degree:

1. Of the 30 points elected to satisfy the residence requirement the candidate must complete courses aggregating not less than 20 points elected from the courses listed by the department.
2. The candidate must submit an essay on a subject approved by the department.
3. The candidate must pass special departmental examinations, consisting of a written examination of two hours and an oral examination of one hour.

For the Ph.D. degree:

Matriculated candidates for the degree of Doctor of Philosophy are required by the Department, at the time of their matriculation, to give evidence of the possession of a practical reading knowledge of French and German. The selection of courses, the number of hours to be devoted to research, and the subject of the Ph.D. dissertation, will be determined in consultation with the executive officer of the department.

Courses in Nutrition (Physiological and Pathological Chemistry)

Biological Chemistry 101 or 102—General physiological chemistry. 2 lectures and 6 hours laboratory. Eligibility, hours and credit to be determined on consultation. Professor GIES and assistants.

A course in the elements of normal nutrition. The course presents the essential chemical facts pertaining to life processes.

Biological Chemistry 211-212—Biochemical methods of research, including clinical methods. 2 lectures and 6 hours laboratory. Eligibility, hours and credit to be determined on consultation. Dr. MILLER.

Prerequisite: *Biological Chemistry 101 or 102.*

Biological Chemistry 221-222—Nutrition in health (advanced physiological chemistry). 2 lectures and 14 hours laboratory. Eligibility, hours, and credit to be determined on consultation. Professor GIES.

Prerequisite: *Biological Chemistry 211-212.*

Biological Chemistry 251-252—Advanced physiological and pathological chemistry, including all phases of nutrition. Research 20 hours. Eligibility, hours, and credit to be determined on consultation. Professor GIES and Dr. MILLER.

Toxicological Chemistry

Biological Chemistry 261-262—Effects and detection of poisons, including food preservatives and adulterants. Laboratory, 10 hours. Eligibility, hours, and credit to be determined on consultation. Professor GIES and Dr. MILLER.

Botanical Chemistry

Biological Chemistry 271-272—Chemical physiology of plants. 1 lecture and 7 hours laboratory. Eligibility, hours, and credit to be determined on consultation. (The course may be taken in whole or in part at the New York

Botanical Garden, where Professor GIES is consulting chemist.) See Botany, below. Professor GIES and assistants.

Bacteriological Chemistry

Biological Chemistry 281-282—Chemistry of micro-organisms; fermentations, putrefactions, enzyme actions in general. Introduction to sanitary chemistry. 1 lecture and 7 hours laboratory. Eligibility, hours, and credit to be determined on consultation. Dr. KRASNOW and assistants.

Seminar

Biological Chemistry 301-302. The members of the teaching staff, candidates for the degree of Doctor of Philosophy and all other investigators in the department, meet weekly to discuss results of recent researches in chemical biology. 1 hour. No course credit. Professor GIES.

Research

Biochemical research may be conducted by advanced workers, independently or under guidance.

The Columbia University Biochemical Association holds quarterly scientific meetings which are open to all students in the University. It also issues the quarterly *Biochemical Bulletin*.

Teachers College

For courses in biochemistry and nutrition applied to household arts; given in Teachers College by Professors GIES, SHERMAN, ROSE, EDDY and HEFT, see the separately printed *Announcement of Teachers College, School of Practical Arts*.

BOTANY

Graduate work in botany presupposes the possession of a knowledge of general botany gained from a study of plants in field and laboratory, supplemented by more special training in plant physiology and morphology and a good knowledge of microscopic technique. The requirement for entering major work is the equivalent of an undergraduate course in botany pursued for three years. By reference to the statement of courses given below the equivalent expected can be seen. For example, Courses 1-2, 3-4 for men or Courses 51-52, 53-54, 153 and 154 or 156 for women might be taken for a minimum, although sufficient training along somewhat different lines may be accepted in lieu of any particular course. Major work in the subject presupposes the ability to commence and carry on successfully a definite line of research. The amount of time required for the completion of a major must necessarily vary in different cases, but some definite piece of work of high quality must be carried through.

For the degree of Master of Arts the Department of Botany requires that the candidate shall complete, first, a specified number of formal courses with examinations and, second, the investigation of an assigned problem with a written report on the work done.

Matriculated candidates for the degree of Doctor of Philosophy are required by the department to have as a preliminary a reading knowledge of French and German.

In addition to the thesis embodying the results of research and the course required for the major subject, the candidate is required to complete research work or a specified number of courses in two minor subjects, one of which must be chosen outside the department. The departmental recommendation for the degree is based on the major and minor work, the completion of the thesis and the final examination.

The proportionate amount of time to be devoted to course work and research and the choice of the courses and the problem will be determined on consultation with the member of the staff with whom the research work is to be done.

A. Undergraduate Courses

Botany 1-2—General botany. 4 points each Session. (Columbia.)

Botany 3-4—Plant morphology. 4 points each Session. (Columbia.)

Botany 7—Growth and character of timber. 2 points Winter Session. (Columbia.)

Botany 9-10—Botanical problems. Introductory to research. 2 points each Session. (Columbia.)

Botany 11—Microscopy of drinking water. 3 points Winter Session. (Columbia.)

Botany 51-52—Principles of plant morphology and physiology. 4 points each Session. (Barnard.)

Botany 53-54—General morphology and development of plants. 4 or 5 points each Session. (Barnard.)

Botany 55-56—Morphology and classification of spermatophytes. 3 or 4 points each Session. (Barnard.)

B. Graduate Courses

Botany 103—Plant morphology, cryptogams. A general survey of the algae, fungi, mosses, and ferns with special reference to the needs of teachers and as a prerequisite to more advanced work. Hours to be arranged. 3 or 5 points each Session. Professor HARPER.

Botany 111-112—Advanced morphology. Organography and development of plants. Hours to be arranged. 3 or 5 points each Session. Professor CURTIS.

Botany 113-114—Advanced morphology. Evolution of Angiosperms. Hours to be arranged. 3 or 5 points each Session. Professor CURTIS.

Botany 115-116—Mycology. Advanced work on the morphology and physiology of fungi, with special reference to forms that cause disease of plants. Hours to be arranged. 3 or 5 points each Session. Professor HARPER and Mr. GERSHOY.

Botany 117-118—Cytology. General physiology of organisms. Lectures and laboratory work upon the reproduction, irritability, and nutrition of the cell. 3 or 5 points each Session. Professor HARPER and Mr. GERSHOY.

Tu. at 4; S. at 11, 505 Schermerhorn.

Botany 121-122—Advanced morphology. Bryophyta and pteridophyta. 3 or 5 points each Session. Professor HARPER and Mr. GERSHOY.

Hours to be arranged.

Prerequisite: Botany 103.

Botany 151-152—Bacteria and ferment fungi. 2 lectures and 6 hours laboratory. 3 or 5 points each Session. Professor RICHARDS, Mrs. COUTANT and Miss BENHAM (Barnard).

Tu. and Th. at 4.

Botany 153—Anatomy of vascular plants. 2 lectures and 6 hours laboratory. 3 or 5 points Winter Session. Mrs. RICHARDS (Barnard).

Tu. and Th. at 11.

[**Botany 154—Physiology of plants from standpoint of nutrition.** 2 lectures and 6 hours laboratory. 5 points (lectures only, 3 points) Spring Session. Professor RICHARDS and Mrs. RICHARDS (Barnard). *Not given in 1922-1923.*]

Botany 156—Physiology of plants from standpoint of growth. 2 lectures and 6 hours laboratory. 3 or 5 points Spring Session. Professor RICHARDS and Mrs. RICHARDS (Barnard).

Tu. and Th. at 11.

Botany 157—Embryology and laboratory methods. Practice in methods of technique, with the study of the embryology of one or more types. 8 hours laboratory with occasional lectures and outside reading. 4 points Winter Session. Professor HAZEN (Barnard). Hours to be arranged.

Botany 158—Structure and development of algae. Advanced course. 1 lecture and 6 hours laboratory. 4 points Spring Session. Professor HAZEN (Barnard). Hours to be arranged.

[**Botany 159—Structure and development of fungi.** Advanced course. 1 lecture and 6 hours laboratory. 4 points Winter Session. Professor RICHARDS (Barnard). Hours to be arranged. *Not given in 1922-1923. To be given in 1923-1924.*]

Botany 161-162—Advanced physiology and morphology. Work will be arranged to suit the needs of the students. 4 to 8 points each Session. Professors RICHARDS and HAZEN and Mrs. RICHARDS (Barnard).

C. Advanced Graduate and Research Courses

Hours and credit for courses in research (Botany 200 to 244) are arranged on consultation and should be recorded at the office of the Registrar.

Botany 201-202—Physiology. Lines of work dealing with various problems in plant physiology, such as the relation of structure and function, growth, the irritable mechanism of the plant, and the permanent adaptive reactions to

environmental factors. 4 or 8 points each Session. Professor RICHARDS and CURTIS.

Botany 209-210—Physiology of nutrition. Treated from a chemical standpoint. 4 or 8 points each Session. Professors RICHARDS and GIES.

Botany 211-212—Plant pathology. Diseases induced by cryptogamic parasites, including work in culture methods. 4 or 8 points each Session. Professor HARPER and Drs. MURRILL and SEAVER.

Botany 217-218—Embryology of spermatophyta. With special work during two summers. 4 or 8 points each Session. Professors CURTIS and HAZEN.

Botany 219-220—Morphology. Work dealing with morphological problems in the various groups of plants. 4 or 8 points each Session. Directed by members of the department and Botanical Garden staff.

Botany 227-228—Taxonomy. Critical study of a family, genus, or other group selected from any division of the plant world. 4 or 8 points each Session. Directed by members of the Botanical Garden staff.

Botany 235-236—Plant distribution. Problems dealing with regional botany or plant geography. 4 or 8 points each Session. Professor BRITTON and other members of the staff.

Botany 241-242—Research on the physiology of the cell and reproduction. 4 or 8 points each Session. Professor HARPER.

Botany 243-244—Plant breeding. Lectures and laboratory work upon the principles of heredity and plant genetics. 4 or 8 points each Session. Dr. STOUT.

Botany 301-302—Seminar for the study of special topics in general physiology and the presentation of the results of investigation. Friday, 4-6. 2 points each Session. Professor HARPER.

Colloquium. A bi-weekly meeting for the discussion of current botanical literature.

Conference. A botanical convention is held monthly at the library of the New York Botanical Garden, where members of the staff and students either present the results of their own work or review the progress of botanical research and publication elsewhere.

Summer Session

Botany s1-s1a—The organization and function of the plant. s1, lectures and laboratory, 4 points; s1a, lectures only, 2 points. Professor CURTIS and assistant.

1:30, 505 Schermerhorn; laboratory, 2:30-4:20, 502 Schermerhorn.

This work deals with the structure of the plant body and emphasizes the physiological activities of these structures as contrasted with those of the animal. A brief survey of the vegetable kingdom is also included. Recommended to those desiring preparation for teaching botany and accepted together with Zoology s1 as meeting the entrance requirements for the Medical School.

Text-book: Curtis' *Nature and Development of Plants*.

Botany s106-s106a—Plant relations and utilizations. s106, 4 points; s 106a, lectures only, 2 points. Professor CURTIS and assistant.
9:30, 505 Schermerhorn; laboratory, 10:30-12-20, 502 Schermerhorn.

Botany s241-s241a—Research. s241, 4 points; s241a, 8 points. Professor CURTIS and Mr. COHN.

Hours to be arranged on consultation.

University Extension

Botany e1-2—Nature and development of plants. Lectures and laboratory. 4 points each Session. Professor CURTIS.

M. and Th., 4:30-5:30 p. m., (lectures). 505 Schermerhorn; M. and Th., 5:30-7 p. m., (laboratory). 502 Schermerhorn. Fee \$32 each Session.

Organs, structure, and work of the plant; development of plant life through an examination of the important biologic types. This course is recommended for pre-medical students, to supplement Zoology e1a-2a; the two courses constitute one year of biology required by law for students intending to study medicine.

Teachers College

Courses dealing with the teaching of botany, open to Seniors and graduates who have completed certain prerequisite courses in subject-matter and education, are given in Teachers College by Professors O. W. CALDWELL and BIGELOW and Mr. FINLEY. See in the current *Announcement of Teachers College, School of Education*.

College of Pharmacy

A course of thirty lectures, thirty recitation hours, and seventy-five hours laboratory work in structural and descriptive botany; a laboratory course of ninety hours in botany applied to the study of drugs; and a course of thirty hours in plant classification are given in the College of Pharmacy.

PATHOLOGY

Courses in Pathology 102, 106, are limited to students who have had the requisite training in Anatomy, Histology, Chemistry and Physiology.

Pathology 102—General and special pathology. 4 lectures and 12 hours laboratory. 12 points Spring Session. Professors JOBLING, PAPPENHEIMER and JOHNSON and assistants.

Pathology 106—Gross pathological anatomy and attendance upon autopsies. 2 points Spring Session. Professors PAPPENHEIMER and JOHNSON and Dr. VON GLAHN.

Limited to students who are taking course 102, or who have completed that course or its equivalent.

Pathology 251-252—Research in pathology. 6-10 points each Session. Under the direction of the professor of pathology. Professors JOBLING and PAPPENHEIMER.

Credit for this course varies according to the arrangement made at the time of registration by the student with the instructor.

Courses under the Institute of Cancer Research

Pathology 202—General biology of tumors. 4 points Spring Session. Professor WOGLOM.

Prerequisite: *Mammalian histology.*

Pathology 205-206—Research in problems of growth pathology with especial reference to tumors. Credit to be assigned in individual cases at the time of registration. 4-12 points each Session. Professors WOOD, WOGLOM and PRIME and Dr. BULLOCK.

Pathology 209—Morphology and classification of tumors, including pathological technique. 4 points Winter Session. Professor WOOD.

Prerequisite: *Mammalian histology.*

The laboratories of the Institute of Cancer Research are open to properly qualified workers for research in pathology under the supervision of the Director of the Institute of Cancer Research.

PHYSIOLOGY

Students who are candidates for one of the graduate degrees with physiology as their primary choice should have some knowledge of physics, chemistry, and biology. The specific requirements for the degree depend, in part, upon the previous preparation of the candidate, and he should always confer with the executive officer of the department before entering upon his work. A candidate for the degree of Master of Arts who has had no previous work in physiology is expected to take either Physiology 105-106 or Physiology 201-202 together with such other work as the department may prescribe.

The hours for each course will be arranged on consultation.

Physiology 2—Elementary physiology. 2 lectures and 4 hours laboratory. 4 points Spring Session. Professor SCOTT.

Physiology 105-106—Human physiology. Lectures 3 hours; demonstration 2 hours; conference 1 hour; laboratory work 4 hours. 8 points each Session. Professors BURTON-OPITZ and WILLIAMS and Drs. BENDER, COOMBS, and HASTINGS.

Physiology 108—Physics of X-rays. Lectures with demonstrations 1 hour; eight weeks. 1 point Spring Session. Professor WILLIAMS.

Physiology 109—Carbohydrate metabolism. Lectures 1 hour. 1 point. Professor SCOTT.

Physiology 201-202—General physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each Session. Professors PIKE, WILLIAMS and SCOTT.

Physiology 203-204—Special physiology. Lectures 1 hour; laboratory work 5 hours. 4 points each Session. Professors BURTON-OPITZ, PIKE, WILLIAMS and SCOTT.

Physiology 205-206—Problems of evolution from the standpoint of physiology. Lectures 1 hour. 1½ points each Session. Professor PIKE.

Physiology 208—Principles of electro-cardiography. Lectures with demonstrations; 1 hour; eight weeks. 1 point Spring Session. Professor WILLIAMS.

Physiology 251-252—Research in physiology. Under direction of the Professor LEE. The officers of the department. Hours to be arranged.

Credit for this course varies according to the arrangement made at the time of registration by the student with the instructor.

Barnard College

A course in general Animal Physiology is given by the Department of Zoology of Barnard College, supplementing the work in general Biology and Zoology. See page 22 and the separately printed *Announcement of Barnard College*.

Three courses in Plant Physiology are given by the Department of Botany of Barnard College: One dealing with Plant Nutrition, Botany 154, a second with Growth, Botany 156, a third with advanced problems in Physiology, Botany 161-162. See page 17 and the separately printed *Announcement of Barnard College*.

Summer Session

For information in regard to the courses in Physiology offered in the Summer Session, see the separately printed *Announcement of the Summer Session*.

Teachers College

The Department of Physical Education of Teachers College offers a course in Physiology Applied to Physical Training. The courses in Applied Biology and Hygiene given in Teachers College are chiefly physiological. For details consult the separately printed *Announcement of Teachers College, School of Practical Arts*.

College of Pharmacy

A course of thirty lectures and thirty recitation in Human Physiology is given in the College of Pharmacy. For details consult the separately printed *Announcement of the College of Pharmacy*.

University Extension

A course of thirty lectures in Elementary Physiology is given under the auspices of the Department of Oral Hygiene. Professor BURTON-OPITZ.

Department of Botany

The following courses deal with Plant Physiology and are given detailed reference under the Department of Botany, p. 17: 201-202, Advanced Physiology (Professors RICHARDS and CURTIS); 209-210, Physiology of Nutrition (Professors RICHARDS and GIES).

ZOOLOGY

Graduate major work in Zoology requires at least two years of preparatory undergraduate study or the equivalent, *i. e.*, an acquaintance with the general principles of Biology, and an adequate knowledge of the comparative morphology and classification of animals, including some training in embryology, histology and microscopical technique. Such a preparation is afforded by Courses 1-2, 3, and 4, or 95-96, 101-102 and 103. For students whose main interest lies in

other subjects less extensive preparation may suffice, but such students must have taken at least one year's work in Zoology or Elementary Biology. Courses numbered below 100 are for undergraduates only.

While formal course work for graduate students is necessary to meet the University requirements, the department lays particular emphasis on the attainment of a high standard of scholarship and of training, as shown particularly by the doctor's dissertation. All candidates for the higher degrees must however satisfy the University residence requirements as defined in tuition-points; and they are expected to attend such courses as the department may recommend, which may include courses in other departments. For the degree of Master of Arts in Zoology at least sixteen of the thirty tuition points prescribed by the University regulations as constituting a year of residence must be taken in the Department of Zoology, together with such other work as the department may require. The degree of Doctor of Philosophy requires a reading knowledge of scientific French and German, and, in addition to other work, a minimum of sixty tuition points of which at least thirty must be taken in residence at this University.

For either degree specially assigned study or research (to be registered as Course 227-228) may in part, with the approval of the department, take the place of formal course-work. To Ph.D. students whose main work is in Zoology, Courses 201, 215-216, 221-222, 223-224, and 225-226 are suggested as a general foundation.

A. Undergraduate Courses

Zoology C1-C2—Human biology. 1 point each Session. (Barnard.)

Zoology 1-2—Elementary biology (zoology.) 2 lectures and 4 hours laboratory. 4 points each Session. (Barnard and Columbia.)

Zoology 4—Elementary embryology. 2 points Spring Session. (Columbia.)

Zoology 5-6—Heredity and evolution. 4 points each Session. (Barnard.)

Zoology 13—Histology and histological methods. 4 points Winter Session. (Barnard.)

Zoology 14—Embryology and embryological methods. 4 points Spring Session. (Barnard.)

Zoology 51—The cell and the tissues. 4 points Winter Session. (Columbia.)

Zoology 95-96—Comparative morphology of vertebrates. 4 points each Session. (Barnard and Columbia.)

Prerequisite: *Zoology 1-2.*

B. Graduate Courses

Zoology 101-102—General zoology. 2 lectures and 6 hours laboratory. 6 points each Session. Professor MCGREGOR (Columbia); Professor CRAMPTON and Mrs. LOWTHER. (Barnard.)

Columbia hours to be arranged.

M., W. and F., 9-12 (Barnard.)

Prerequisite: *Zoology 1-2.* This course may be counted towards M.A. or minor Ph.D. work, but it will not be accepted as part of the major requirements for the Ph.D. degree.

Zoology 103—Comparative embryology of vertebrates. 1 lecture and 2-5 hours laboratory. 3 points Winter Session. Professor MCGREGOR.
F. at 9. 619 S.

Zoology 108—Parasitology. 2 lectures and 2 hours laboratory. 4 points Spring Session. Professor CALKINS.
Hours to be arranged.

Zoology 151-152—General physiology. General principles of human and animal physiology. 2 lectures and 4 hours laboratory. 4 points each Session. Professor L. H. GREGORY (Barnard). Open to women only.
Tu. and Th., 9-12.

C. Advanced Graduate Courses

General Zoology

The two following courses are designed to complete the work in general zoology begun in *Zoology 1-2* and continued in *Zoology 101-102*. Special works and monographs are extensively used in these courses. Critical discussions on general anatomy and development, with special reference to the problems of phylogeny and classification.

Zoology 201—Topics in invertebrate zoology, with especial reference to problems of phylogeny. 2 lectures and 8-10 hours laboratory. 8 points Winter Session. Professor WILSON.

Zoology 223-224—Evolution of the vertebrates. 2 lectures and 4 hours laboratory. 5 points each Session. Given at the American Museum. Professor W. K. GREGORY.

Hours to be arranged.

Fishes, recent and fossil; amphibia and reptiles; origin of the birds; origin of the mammals; systematic, phylogenetic, and morphological studies. Evolution of the head and locomotive apparatus of vertebrates. The material studied comprises over 700 specimens of recent and fossil types.

Zoology 211-212—Comparative myology of the vertebrates. 1 lecture and 5-10 hours laboratory. 4 points each Session. Professor W. K. GREGORY.

Hours to be arranged.

Zoology 220—Cellular embryology. 1 lecture and 3 hours laboratory. 3 points Spring Session. Professor WILSON.
Hours to be arranged.

A comparative treatment of the earlier stages of development, with especial reference to the internal factors of morphogenesis and the general problems of developmental mechanics. To be taken only with, or subsequent to, *Zoology 225-226*.

Zoology 225-226—Cellular biology. 2 lectures and 6 hours laboratory. 3 or 6 points each Session. Professor WILSON.

Hours to be arranged.

General structure and functions of the cell with especial reference to development and heredity, cytology and cellular embryology.

Morphology and Evolution of Special Groups

Zoology 203-204—Mammals, living and fossil. 1 lecture and 5-10 hours laboratory. 4 points each Session. Professor W. K. GREGORY.

S., 10-4. American Museum of Natural History.

Structure, origin, and phylogeny of the principal groups. Structural adaptations. Parallel and convergent evolution. Study of recent and fossil material at the American Museum.

Protozoology

The courses here offered are designed to give a basis for research on unicellular animals. Particular attention is given to the life histories, to the relation of Protozoa to human disease, and to methods of research in this group of organisms.

Zoology 221-222—Protozoology. A general treatment of the Protozoa from the standpoints of general biology, taxonomy, cytology, and physiology. 1 lecture and 7 hours laboratory. 5 points each Session. Professor CALKINS.

S., 9-4, Lecture, 10-11, 619 Schermerhorn.

Zoology 230—Experimental protozoology. 1 lecture and 5 hours laboratory. 4 points Spring Session. Professor CALKINS.
Hours to be arranged.

The application of experimental methods of research to Protozoa with special reference to the problems of growth, cell division, regeneration, fertilization, and age. Individual research problems.

Prerequisite: *Zoology 221*.

Experimental Zoology

The following courses (215-216, 217-218 with 213-214) cover three year's work. Each course may be taken independently of the others and not necessarily in the order given.

Zoology 213—Tropisms. 1 lecture and 5 hours laboratory. 4 points Winter Session. Professor T. H. MORGAN.

Hours to be arranged.

This course deals with the simpler responses of organisms to external agents and serves as an introduction to the next course, *Zoology 214*.

Prerequisite: *Zoology 1-2, 101-102*.

Zoology 214—Instincts. An analysis of the more complex behavior of animals and the problems of the evolution of instinct and intelligence. 1 lecture and 5 hours laboratory. 4 points Spring Session. Professor T. H. MORGAN.

Hours to be arranged.

Prerequisite: *Zoology 1-2, 101-102*.

Zoology 215-216—Genetics. Laboratory work on special problems. 2 lectures and 6 hours laboratory. 6 points each Session. Professor T. H. MORGAN.
Hours to be arranged.

Approximately two-thirds of the year is given to Mendelian heredity and genetics; the remainder to the influence of environment in modifying organisms and in affecting their modes of reproduction (sex determination).

Zoology 217-218—Physiological basis of development. 1 lecture and 5 hours laboratory. 4 points each Session. Professor T. H. MORGAN.
Hours to be arranged.

A discussion of theories dealing with the relation of function to structure.

Special Research

Zoology 227-228—Investigation of special problems in any of the subjects enumerated above. Variable. Not in general counted as part of course-work.

Courses in Biometrical Methods

See current *Announcement of Philosophy, Psychology and Anthropology*

Summer Session

Zoology s1—Elementary biology and zoology. Lectures and laboratory work. Credit I. 4 points.

Prerequisite: *Natural Science A*, or *Elementary Chemistry*, or *Physics*.

NOTE: This course is not the exact equivalent of *Zoology 1*. Although elementary, it is not sufficiently simple to be adapted to the needs of high school pupils.

In the requirements for the Medical School the above course will supplement *Botany s1-s1a*. The class will be limited to forty students.

Zoology s121—Protozoology. Lectures, demonstrations, and laboratory work amounting to not less than twenty-four hours per week. 10 points. Professor CALKINS.

Given at the Marine Biological Laboratory, Woods Hole, Mass.

University Extension

Zoology e1—Elementary biology and zoology. Lectures and laboratory. 4 points Winter Session.

Zoology e2—Vertebrate zoology and evolution. Lectures and laboratory. 4 points Spring Session.

University Extension (Brooklyn)

Zoology e1-2—General biology and zoology. 4 points each Session.

Zoology e4—Advanced biology. 2 points Spring Session (alternates with e8).

Zoology e5-6—Vertebrate comparative morphology. 3 points each Session.

Zoology e8—Human parasitology. 3 points Spring Session.

Teachers College

Courses dealing with the teaching of biology, open to Seniors and graduates who have completed certain prerequisite courses in subject matter and education, are given in Teachers College by Professors O. W. CALDWELL and BIGELOW and MR. FINLEY. See Biology in the current *Announcement of Teachers College, School of Education*.

ACADEMIC CALENDAR

1922-1923

1922

July 10, Monday. **Twenty-third Summer Session begins.**

(Registration in Summer Session begins Thursday, July 6.)

Aug. 1, Tuesday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October. Last day for filing applications for deficiency and special examinations. The privilege of later application may be granted on payment of a fee of \$6.

Aug. 18, Friday. **Twenty-third Summer Session ends.**

Sept. 11, Monday. Last day for filing applications for entrance examinations, and for advanced standing. The privilege of later application may be granted on payment of a fee of \$6.

Sept. 18, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.

Sept. 20, Wednesday. **Registration** (including the payment of fees) **begins.** Registration in University Extension (including the payment of fees) begins.

Sept. 22, Friday. Registration in Barnard College (including the payment of fees) begins.

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Sept. 26, Tuesday. Registration ceases for students previously matriculated, except graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$6.

Sept. 27, Wednesday. **Winter Session, 169th year, begins.** Registration ceases for students not previously matriculated, except graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$6.

Sept. 28, Thursday. Classes begin.

Sept. 30, Saturday. Registration ceases for graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts. The privilege of later application may be granted up to October 21 on payment of a fee of \$6.

Oct. 2, Monday. Last day for filing applications for all degrees to be conferred in October, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy.

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- The privilege of later application may be granted on payment of a fee of \$6.
- Oct. 3, Tuesday. Last day for filing essays for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October.
- Oct. 7, Saturday. Last day for making changes in program, except for graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts.
- Oct. 17, Tuesday. Stated meeting of University Council.
- Oct. 21, Saturday. Last day for receiving late applications for registration and for making changes in program for graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts.
- Nov. 7, Tuesday. Election Day, holiday.
- Nov. 28, Tuesday. **Annual Thanksgiving Service** in St. Paul's Chapel.
- Nov. 30, Thursday, to December 2, Saturday, inclusive. Thanksgiving holidays.
- Dec. 4, Monday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in February.
- Dec. 19, Tuesday. Stated meeting of University Council.
- Dec. 20, Wednesday, to

1923

- Jan. 7, Sunday. **Annual Commemoration Service** in St. Paul's Chapel.
- Jan. 11, Thursday. Last day for filing applications for entrance examinations. The privilege of later application may be granted on payment of a fee of \$6.
- Jan. 18, Thursday. Mid-year entrance examinations begin.
- Jan. 24, Wednesday. Mid-year examinations begin.
- Jan. 29, Monday. Mid-year examinations in University Extension begin.
- Feb. 1, Thursday. Registration in University Extension (including the payment of fees) begins.
Last day for filing applications for all degrees to be conferred in February, except Master of Arts, Master of Science, Master of Laws, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$6.
- Feb. 3, Saturday. **Registration** (including the payment of fees) **begins**.
- Feb. 6, Tuesday. **Winter Session ends**. Registration ceases for all students entering Spring Session. The privilege of later registration may be granted up to March 3 for graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts on payment of a fee of \$6.
Last day for filing essays for the degrees of Master of Arts, Master of Science,

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- Jan. 2, Tuesday, inclusive. Christmas holidays.

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- and Master of Laws to be conferred in February.
- Feb. 7, Wednesday. **Spring Session begins.**
Classes begin.
- Feb. 12, Monday. Alumni Day.
- Feb. 17, Saturday. Last day for making changes in program, except for graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts.
- Feb. 20, Tuesday. Stated meeting of University Council.
- Feb. 22, Thursday. Washington's Birthday, holiday.
- Mar. 1, Thursday. Last day for filing applications for University Fellowships and Scholarships.
Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in June.
Last day for filing applications for deficiency and special examinations except in the School of Law. The privilege of later application may be granted on payment of a fee of \$6.
- Mar. 3, Saturday. Last day for receiving late applications for registration and for making changes in program for graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts.
- Mar. 29, Thursday, to Apr. 2, Monday, inclusive. Easter holidays.
- Apr. 3, Tuesday. Last day for filing applications for examination for the degree of Doctor of

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- Philosophy to be conferred in June.
- Apr. 16, Monday. Last day for filing applications for all degrees to be conferred in June, except Master of Arts, Master of Science, Master of Law, and Doctor of Philosophy. The privilege of later application may be granted on payment of a fee of \$6.
- Apr. 17, Tuesday. Stated meeting of University Council.
- May 1, Tuesday. Last day for students in Columbia College to file choice of studies for following year. The privilege of filing such choice late may be granted on payment of a fee of \$6.
Last day for filing applications for scholarships in the Schools of Law, Applied Science, and Architecture.
- May 21, Monday. Final examination for all courses begin.
- May 23, Wednesday. Last day for filing essays for the degree of Master of Arts, Master of Science, and Master of Law to be conferred in June.
- May 30, Wednesday. Memorial Day holiday.
- June 3, Sunday. **Baccalaureate Service.**
- June 4, Monday. Class Day.
- June 6, Wednesday. **Commencement Day.**
- June 13, Wednesday. **Spring Session ends.**
- June 18, Monday. Entrance examinations begin.
- July 9, Monday. **Twenty-fourth Summer Session begins.**
(Registration in Summer Session begins Thursday, July 5.)

1923

Aug. 1, Wednesday. Last day for filing applications for the degrees of Master of Arts, Master of Science, and Master of Laws to be conferred in October.

Last day for filing applications for deficiency and special examinations. The privilege of later application may be granted on payment of a fee of \$6.

Aug. 17, Friday. **Twenty-fourth Summer Session ends.**

Sept. 10, Monday. Last day for filing applications for entrance examinations, and for advanced standing. The privilege of later application may be granted on payment of a fee of \$6.

Sept. 17, Monday. Examinations for entrance, advanced standing, and for deficient and debarred students begin.

Sept. 19, Wednesday. **Registration** (including the payment of fees) **begins.**

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Registration in University Extension (including the payment of fees) begins.

Sept. 21, Friday. Registration in Barnard College (including the payment of fees) begins.

Sept. 25, Tuesday. Registration ceases for students previously matriculated, except graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$6.

Sept. 26, Wednesday. **Winter Session 170th year, begins.** Registration ceases for students not previously matriculated, except graduate students in Political Science, Philosophy, Pure Science, Business, Education, and Practical Arts. The privilege of later registration may be granted on payment of a fee of \$6.

UNIVERSITY OF ILLINOIS-URBANA



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